Project funded by the EUROPEAN UNION

ENPI CBCMED CROSS-BORDER COOPERATION IN THE MEDITERRANEAN

DIDSOLIT-PB

Egyptian Association for

Energy and Environment (EAEE)

Egyptian Association for Energy and Environment (EAEE)

CALL FOR TENDER

Design, Supply, Delivery, Installation and Commissioning of 79.2 kWp Grid – Connected Solar Photovoltaic Systems in Matrouh Governorate

Closing Date: 17-02-2015

Address: Engineering tower no.3, 28th floor, Cornish El Maadi, Cairo, Egypt

Telephone: +(202) 25266038

e-mail: info@eaee-eg.com

Contents

1 Purpose 3
2. Project Title 3
3 General Terms and Conditions 4
3.1 Term of reference 4
3.2 Tender time plan 5
3.3 Tender Bond 6
3.3.1 Bid bond 6
3.3.2 Performance guarantee bond 6
3.3.3 Maintenance and Operational guarantee bond 7
3.4 Documents Comprising the Bid 7
3.5 Bid Opening 7
4 Offer format 10
4.1 Technical offer 10
4.2 Financial offer 11
5. Evaluation Criteria 12
5.1 Evaluation Step 1: Qualifications and general requirements: 12
5.2 Evaluation Step 2: Technical evaluation (out of 70 marks): 12
5.3 Evaluation step 3: Financial evaluation(out of 30 marks): 13
6 Method of Payment (Term of Payment) 14
7 System operation performance testing 14
8 Penalties 15
9 Annexes 15

List of Tables

Table 1 : Tender time plan 5
Table 2 : Technical evaluation criteria 13
Table 3 : Financial evaluation criteria 14

Project funded by the EUROPEAN UNION

ENPI CBCMED

DIDSOLIT-PB

Egyptian Association for Energy and Environment (EAEE)

Design, Supply, Delivery, Installation and Commissioning of 79.2 kWp Grid – Connected Solar Photovoltaic Systems

Call For Tenders

1. Introduction

The Egyptian Association for Energy and Environment (EAEE) is implementing a project funded by the European Union-ENPI CBCMED-cross border cooperation at the Mediterranean, titled "Developing and Implementing Decentralized Innovative Solar Energy Technologies in Public Building (DIDSOLIT-PB) " where as the project aims to :

- Transfer up-to-date- solar energy uses technologies
- Transform the governorate's public buildings into energy saving buildings through the installation of developed solar systems that generate energy of total capacity of 79.2 kWp to be used in lighting and air-conditioning
- Provide technical support and create new expertise in the field of solar energy technology.

The growing concern for the use of renewable energies and the reduction of CO2 emissions of the society has led the Public Administrations to promote Projects regarding alternative energy sources.

Photovoltaic solar energy presents itself as a clean and environmentally friendly alternative. In addition, it has the advantage, due to its morphology, of being easily integrated in urban environments, where most of the demand and energetic consumption is concentrated.

2. Purpose

This tender aims at Design, Supply, Delivery, Installation Commissioning and Maintenance of 79.2kWp Grid- connected solar Photovoltaic to be installed on

the roof spaces available on the selected four buildings. The proposed systems shall comply with the relevant laws and regulations issued by the Ministry of Electricity and Renewable Energy , Egyptian Electric Regulatory Agency (EERA), and in line with the requirements of the Behira Electricity Distribution Company (BEDC).

The proposed On-grid solar PV system shall generate electrical power directly to Low Voltage (LV) distribution gird supply during daytime sharing the load with system maximum outlet at any time . In the event where energy generated by the solar system is larger than the operation load, for example in weekend and vacation, the system must have the ability to automatically feed national grid.

3. General Terms and Conditions

3.1 Terms of reference

3.1.1 All proposed documents are considered confidential and can only be shared with the EAEE and its third party consultant team.

3.1.2 The Bidder shall submit two original hard and soft copies (CD's) with two separate envelopes (one envelope for the technical offer and the other for the financial offer) sealed and stamped; any bidder who mixes the technical and financial offers will be directly disqualified.

3.1.3 The envelope with the financial offer will only be opened for the Bidders who pass the technical evaluation, the financial offer of the disqualified technical ones will be returned back to the Bidder sealed and stamped.

3.1.4 The Bidder must fill the Technical Data Sheets of PV modules and inverter as described in the Executive Project and submit it in the technical offer, knowing that not completing and submitting the technical data sheets will directly disqualify the offer. [Annex 1: Executive Technical Project].

3.1.5 Bids shall be valid for a period of 120 days after Bid opening date and shall be delivered by hand to EAEE headquarter: Engineers tower no.3, 28th floor, Cornish El Maadi, in front of (شرطة المسطحات المائية), Cairo, on or before 12:00 noon local time of Thursday 17th of February 2015.

3.1.6 All Prices shall be clear and in Egyptian pounds (LE) currency, excluding any customs fees and Sales taxes as the project is exempted from both of them.

3.1.7. Electrical engineering and design shall be complied with Industry Standards, the National Electric Code, IEEE 1547-2003 "IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems." and other applicable codes and standards.

3.1.8 It is the Bidder's responsibility and on his own expenses to visit and understand the site conditions, environment and all requirements that are related to the tender or that may affect the offer price. The bidder will be fully responsible for verifying any information, drawings and measurements that may be available to him. A site visit must be performed by all Bidders.

3.1.9 All questions regarding the tender by the bidder will be submitted by e-mails and are to be sent to (info@eaee-eg.com) and once answered, will be circulated among all contractors who have submitted their proposals.

3.1.10 The deadline of the questions and the answers is shown in table(1) below. No question will be considered after the mentioned date.

3.1.11 The Tender will be awarded as one lot for the most suitable technical and financial offer based on the evaluation criteria explained in section (14).

3.1.12 All Permits required to execute the Work are the responsibility of the Contractor. The contractor shall identify known Permit requirements. The cost of preparing, filing and obtaining the Permits shall be included in the offered Price. The Contractor shall provide EAEE copies of all approved Permits and applications for Permits still in process on the effective date of the contract.

3.1.13 The Bidder shall provide an evidence that the photovoltaic modules manufacturer has been operating in the business of Solar panels market for the past ten (10) years.

3.1.14 The Contractor shall provide a free maintenance period for two years from the date of the installed system final acceptance, and could be extended for another 3 years based on the contractor performance. The 3 years maintenance offer shall be included in the financial offer as an optional item with the validity of one year.

3.1.15 A bi- monthly inspection report of the system performance and checkup shall be provided during the two years free maintenance period relevant to (maintenance and operational bond section 3.3.3)

3.1.16 A standard Contract of project Design, Delivery, Installation and Commissioning in accordance with Industry Standards will be signed between EAEE and the contractor witnessed by the third party consultant to be the reference of all project phases execution.

3.1.17 EAEE reserves the right to reject any technical offer without clarifying the reasons.

3.2 Tender time plan

Table 1 . Tender time plan

Milestone	Date	Time
Release of Tender Book	December 11 th , 2014	9.00am
Deadline for questions	January 1st , 2015	2.00pm
Release of answers to questions	January 8rd , 2015	5.00pm
Deadline for offers	February 17th ,2015	12.00pm

3.3 Tender Bond

3.3.1 Bid bond

- A bid bond of 70000LE shall be enclosed in the technical offer envelope.
- The bid bond shall be presented by irrevocable and unconditioned LG and issued by a local bank .
- The winning Bidder shall consider that this amount will be paid on first demand if it becomes evident that information given contained false statements.
- The validity of the bid bond is 180 days from date of offers submission with the ability to be automatically renewed unless released by EAEE.
- The bid bond will be returned after signing the agreement, and the performance bond has been duly entered into execution.
- If the winning Bidder fails to provide a performance bond within 14 days of being requested by the EAEE to do so; the full amount of tender bond shall become payable and might be liquidated by EAEE as compensation for such failure.

3.3.2 Performance guarantee bond

- Performance guarantee bond of 10% of the contract price shall be delivered by the awarded Contractor within 14 days of being notified by a registered letter that he has been awarded the contract and in any case prior to signing the contract agreement and the awarding decision.

- Performance guarantee bond shall be irrevocable and unconditioned LG, issued from a local bank and approved by the EAEE in respect of performance of the contract and will be released after the 2 years maintenance free period.

- The Performance Bond shall be in force until a clean final handing over certificate is issued by EAEE for the four sites.

- The bond should be paid on first demand without any objection.

- In order to guarantee the proposed energy yield and performance ratio (PR) of the proposed system, the third party consultant will conduct a system energy yield and performance ratio check after the first and second years of system operation in order to verify the proposed values.

- The bond guarantees the two years of free maintenance and will be released after submitting the final inspection report of the PV system and after the successful achievement of the proposed energy yield and performance ratio values during the bond period.

- The allowed variation of the proposed energy yield value is not more than -5% and the PR is not less than the proposed value for the first two years of operation.

- The contractor shall repair or modify the installed PV system upon failure of achieving the proposed values within the bond period.

- In case of not repairing the failure, the repair shall be done by others and the contractor shall bear all the expenses.

3.4 Documents Comprising the Bid

The Bidder shall prepare two original sets and one copy comprising the Bid and supplementary information. The bid consists of two envelopes:

Envelope A (Technical Offer)

The technical offer shall include:

- Stamped Tender Document including filled out tables and data sheets for PV modules, inverters, monitoring, control, scada remote monitoring, LED screens.
- The technical specifications of the main spare parts sufficient for three years operation after the guarantee period with a value of 2% of the BOS works.
- Original catalogues for all equipments .
- Detailed drawings as specified in P2 of Annex 1 .
- The proposed detailed training program for the personnel of Matrouh Governorate, school, hospital and library .
- The origin of the equipment should be clearly defined taking into account that it must be EU origin .
- Site visit declaration .
- Any other equipments and materials required to be completed and submitted by bidder, all as specified in the Executive Project .
- Time schedule of the project as specified in the Executive Project .

Only technical envelope will be opened in the presence of the bidders or their representatives on February 17th, 2015 at EAEE headquarter in Maadi.

Envelope B (financial offer)

The financial offer shall include:

- Lot (1): The total price and an itemized price list for the foreign deliveries (prices shall be quoted CIP to site) excluding custom duties, and sales taxes on imported equipment (LE).
- Lot (2): The total price and an itemized price list for spare parts sufficient for 3 years(LE)
- Lot (2): The total price for installation and Commissioning of equipment (L.E)
- Lot (2): The total cost of maintenance for 3 years after the free maintenance
- Lot (2): The total as well as man/week cost for training of Matrouh Governorate personnel (LE)

All above items are grouped and included in the Bill of Quantities tables (Measurments , Lot 1&2) . Infrastructures (Lot1) and Services (Lot2) should be invoiced separately in order we can justify our budget lines. The Bidder who merges the offers of Lot (1) and Lot(2) together in one offer will be directly disqualified. Financial envelope shall be opened for the technically accepted bids at a date to be fixed later.

3.5 Bid Opening

EAEE will open the bids in two stages:

- **First Stage**

The technical envelope should be accompanied by the bid security (Lot1 and Lot 2) for an amount of 70000L.E. It will be opened at the bid closing date.

- **Second Stage**

Envelope (B) containing the financial offer will be safe guarded by the EAEE until completion of the evaluation of the technical offer.

EAEE will inform the bidders whose technical bids have been accepted of the date of opening of Envelope B. The financial Envelope B, will be opened in the presence of the bidder's representatives who choose to attend at the time and in the place specified by EAEE. The bidders'names, the Bid prices, will be announced at the session of opening the financial envelopes.

- **Notification of Award and Signing of Contract**

The bidder whose bid has been accepted will be notified of the award by EAEE prior to expiration of the bid validity period by email confirmed by registered letter.

The "Letter of Award" will state the sum that EAEE will pay to the Contractor in consideration of execution, completion, and maintenance of the works, supply of equipment & services by the Contractor as prescribed by the Contract.

- **Advanced Payment**

EAEE will provide an Advanced Payment on the Contract Price according to the terms of payment, to be paid against an irrevocable bank letters of guarentee to the same value and currency in favour of EAEE presented within two weeks from signing the Contract.

4. Offer format

4.1 Technical offer

The response to this TOR must be in the English language, structured (and presented in the same sequence) as follows:

Cover letter

The cover letter must be signed by person(s) authorized to submit the proposal and must delineate the company's ability to fulfill the project.

Chapter 1: Company Profile

The company profile must include registration certificates, J.V if applicable, references projects and C.Vs of the employees.

Chapter 2: Terms of reference

The bidder shall include the TOR of his company in general, man power of the company and the compatibility with DIDSOLIT PV project terms of reference.

Chapter 3: Technical description

This includes the Solar radiation on the site, site and installation criteria, boundaries, shade analysis, structural, civil and electrical assessment, and any relevant information.

Chapter 4: Component and equipment selection

This chapter shall include all selected materials and components and taking into consideration to attach the data sheets in the Annex section.

Chapter 5: Technical Design description

The Bidder shall include but not limited to the software design and results, AutoCAD drawings, 3D drawings and system layout, as well as the mounting system calculations as shown in Annex 1 .

Chapter 6: Approach and Methodology (Scope of work)

The Bidder shall explain the proposed PV system work plan, including the procurement, installation, commissioning, testing and O&M of the PV system.

Chapter 7: Time plan

The Bidder shall propose a time plan of the project implementation phases .

Chapter 8: Training plan

The Bidder shall propose a training plan .

Chapter 9: Testing and commissioning plan

The Bidder shall propose a commissioning and testing plan.

Chapter 10: Safety plan

Chapter 11: Spare part list

Annexes to be attached by the Bidder:

The Bidder shall attach the following items in the annex

Annex: Technical Compliance Sheets

Annex: Tender offer

Annex: Bid bond

Annex: Warrantee and Guarantee of the equipment

Annex: Environmental Benefits

Annex: others

4.2 Financial offer

Chapter 1: Terms of Payment

The Bidder shall propose the terms of payment as an EPC offer, excluded Customs duties and VAT.

Chapter 2: PV system cost break down

The Bidder shall include a Bill of quantity for all materials and equipment proposed in the offer (P3 of annex 1).

The Bidder shall submit the cost break down of the proposed PV system presented above as "Financial measurements sheet" clarified in Annex1.

Chapter 3: Maintenance offer

The Bidder shall provide in the main offer the cost of the following:

1. Three years additional maintenance contract
2. Spare parts

5. Evaluation Criteria

The evaluation for the offers will go through the following three steps:

5.1 Evaluation Step 1: Qualifications and general requirements:

Compliance with TOR documents will be evaluated. The key criteria, which will be used to evaluate responses to the TOR include:

- Experience in designing similar Solar Photovoltaic systems, specifically roof top Projects;
- Available resources to undertake the project;
- Team qualification/ project manager and site engineer experience.
- Quality of proposal documentation received and perceived understanding by the firm of project's requirements;
- Availability of local manpower support for the systems.

5.2 Evaluation Step 2: Technical evaluation (out of 70 marks):

The offer must achieve a score of more than 80/100 to be considered as a technically qualified one, the qualified offer mark will be scaled to 70%.

The following criteria will be the base of the technical evaluation:

- Company qualification: 20%
- Design compliance: 35%
- Quality of proposed products: 22%, distributed as the following:
  - 6% for PV module.
  - 6% for inverters that comply with the technical specifications.
  - 6% for mounting structures that comply with the technical specifications.
  - 2% for DC and AC cabling
  - 2% other components
- Warranties, maintenance and technical support: 15%
- Methodology, time plan and testing plan: 3%
- Aesthetic view: 3%
- Training experience: 2%

Table 2 : Technical evaluation criteria

Company qualification	**20**
Design compliance	**35**
Quality of proposed products	**22**
Warranties, maintenance and technical support	**15**
Methodology, time plan and testing plan	**3**
Aesthetic	**3**
Training	**2**
TOTAL	**100**

5.3 Evaluation step 3: Financial evaluation(out of 30 marks):

Financial evaluation will be evaluated (out of 30 marks).

Table 3 : Financial evaluation criteria

Levelised cost (LE/kWp)	**70**
Payment terms	**30**
TOTAL	**100**

The Bidder who achieves 80% in the technical evaluation will be considered into the financial evaluation; The Bidder who does not achieve at least 80% in the technical evaluation will receive back his financial offer sealed and stamped and without going into any further negotiation with EAEE or its third party consultant.

EAEE and its third party consultant will go into negotiation with the best three offers.

EAEE is free to choose the best option from the three best offers.

6. Method of Payment (Term of Payment)

- The Bidder shall submit a proposed method of payments as an EPC offer.
- The proposed payment method should consider the project phases, Bills of Quantities and the percentage of Project completion
- The Bidder is allowed to propose financing attractive options.

7. System operation performance testing

- The EAEE's third party consultant will perform an Energy yield and Performance ratio assessment (called here after performance check) after the first and second years of system operation.

- The performance check is to confirm that the system energy yield shall not be less than 5% of the proposed value by the Bidder.
- The performance check is to confirm that the performance ratio(PR) of the installed PV is not less than the proposed value during the first two years of operation.
- In case the result of the performance check fails to achieve the mentioned criteria in the first year, the Contractor will be notified to repair any problem or system inconvenience.
- In case the Contractor fails to repair the PV system operation at the end of the second year, the maintenance and operational guarantee bond will be liquidated.
- The successfulness of performance check results releasing the maintenance and operational guarantee bond.

8. Penalties

- If the main Contractor fails to complete the works of any Building within the time for completion, EAEE has the right to apply delay penalties as follow:

- 1% of contract price for the first week
- 2% of contract price for the second week
- 3% of contract price for the third week
- 4% of contract price for the fourth week
- 5% of contract price for each month or any part of it.

Such that it does not exceed 15% of the final contract price, the penalty shall be applied without any need for notice or legal action, upon delay takes place.

- EAEE has the right to cancel all or part of this penalties, if the main contractor introduce an acceptable excuse for such delay.

- The penalty of the un-successfulness of the performance check in the second year is liquidating the performance guarantee bond.

9. Annexes

Annex 1: Executive Project
Annex 2: Project Technical Specification
Annex 3: Tender Technical Specification
Annex 4: Health and Safety
Annex 5: PV Modules Data Sheet

Project funded by the EUROPEAN UNION

ENPI CBCMED

DIDSOLIT-PB

Egyptian Association for

Energy and Environment (EAEE)

ANNEX 1

BIPV SYSTEM

Executive Project

WW.DIDSOLIT. EU

Summary

Reference Standards 5

P1. Description Report 10

1 Building Integrated Photovoltaic 11

1.1 Introduction 11

1.2 Solar photovoltaic energy integrated in buildings 18

1.2.1 Advantages of the system 11

1.2.2 System Diagram Block 12

1.3 System working principle 12

1.3.1 Self-Consumption 12

1.3.2 Self-Consumption with Zero Injection to the Grid 13

1.3.3 Inverters 15

1.3.4. Classification 16

1.3.5. Protections (Anti islanding protection) 16

2 Site Description 17

3 General System 22

4 System's Components 23

4.1 Photovoltaic module 23

4.1.1 Crystalline silicon technology 27

4.1.2 Glass laminated Thin Film technology 30

4.1.3 Laminated flexible Thin Film technology 35

4.2 Inverter selection 38

4.2.1 Unique orientation 39

4.3 Low voltage installation 49

4.3.1 General cables 49

4.3.2 DC - Miniature Circuit Breakers (MCBs) 51

4.3.3 DC - Surge Protective Devices (SPDs) 51

4.3.4 DC - Circuit Breakers 52

4.3.5 AC - Distribution board 52

4.3.6 AC - Miniature Circuit Breakers (MCBs) 52

4.3.7 AC - Circuit breakers 53

4.3.8 AC - Residual-Current Device (RCD) 53

4.3.9 Interconnecting photovoltaic installation 53
4.3.10 Electrical outlet company junction 54
4.3.11 Electronic devices description detail 54
4.3.12 Over current protection systems 55
4.3.13 Over voltage protection systems 55
4.3.14 General Protection Box 55
4.3.15 Systems of differential protection for people 55
4.3.16 Grounding security system 56
4.4 Electrical detail scheme 57
4.4.1 Monitoring and Zero Grid Injection 62
5 Support System Description 64
5.1 Considerations to analyze 64
5.1.1 Snow loads 62
5.1.2 Wind loads 64
5.1.3 Maintenance overloads 65
5.1.4 Building's category 65
5.2 Photovoltaic Solutions 65
5.2.1 Roof and Skylight 66
5.2.2 Pergola 67
5.3 Construction details 69
5.3.1 Fixation details 69
5.3.2 Wiring Conduction 70
6 System Maintenance 71
7 Energy Study 70
8 Environmental Balance 75
9 Bibliography 75
Annex I. PVSyst Simulation 77
Annex II. Working Plan 79
Annex III. Monitoring System 80
1 Features of Monitoring System 82
2 Devices for the zero injection 84
Annex IV. Supporting Calculations 87

1 Electrical Calculations 87
1.1 Voltage drop 87
1.2 Wiring sizing 88
2 Environmental impact 89
P2. DRAWINGS AND SCHEMES 89
2.1 Location 94
2.2 Site 96
2.3 General Plan 97
2.4 Electrical single line schemes 98
2.5 Electrical scheme 100
2.6 Construction details 102
P3. MEASUREMENTS 103

Reference Standards

This project fulfils the recommendations of the following regulations:

SOLAR CELLS	
EN 50513	Solar Wafers - Data sheet and product information for crystalline silicon wafers for solar cell manufacturing
EN 50461	Solar cells - Datasheet information and product data for crystalline silicon solar cells
IEC 60891	Procedures for temperature and irradiance corrections to measured I-V characteristics of crystalline silicon photovoltaic devices
IEC 60904-1	Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics
IEC 60904-2	Photovoltaic devices - Part 2: Requirements for reference solar cells
IEC 60904-3	Photovoltaic devices - Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data
IEC 60904-4	Photovoltaic devices - Part 4: Reference solar devices - Procedures for establishing calibration traceability
IEC 60904-5	Photovoltaic devices - Part 5: Determination of the equivalent cell temperature (ECT) of photovoltaic (PV) devices by the open-circuit voltage method
IEC 60904-7	Photovoltaic devices - Part 7: Computation of spectral mismatch error introduced in the testing of a photovoltaic device
IEC 60904-8	Photovoltaic devices - Part 8: Measurement of spectral response of a photovoltaic (PV) device.
IEC 60904-10	Photovoltaic devices - Part 10: Methods of linearity measurement
ASTM E973	Standard Test Method for Determination of the Spectral Mismatch Parameter Between a Photovoltaic Device and a Photovoltaic Reference Cell
ASTM E1021	Test Methods for Measuring Spectral Response of Photovoltaic Cells
ASTM E1040	Standard Specification for Physical Characteristics of Nonconcentrator Terrestrial Photovoltaic Reference Cells
ASTM E1143	Standard Test Method for Determining the Linearity of a Photovoltaic Device Parameter with Respect To a Test Parameter
ASTM E1125	Standard Test Method for Calibration of Primary Non-Concentrator Terrestrial Photovoltaic Reference Cells Using a Tabular Spectrum

SOLAR MODULES	
IEC 61215	Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval
IEC 61277	Terrestrial photovoltaic (PV) power generating systems - General and guide
IEC 61345	UV test for photovoltaic (PV) modules
IEC 61646	Thin-film terrestrial photovoltaic (PV) modules - Design qualification and

	type approval
IEC 61701	Salt mist corrosion testing of photovoltaic (PV) modules
IEC 61730-1	Photovoltaic (PV) module safety qualification - Part 1: Requirements for construction
IEC 61730-2	Photovoltaic (PV) module safety qualification - Part 1: Requirements for testing
IEC 61829	Crystalline silicon photovoltaic (PV) array - On-site measurement of I-V characteristics
IEC 62108	Concentrator photovoltaic (CPV) modules and assemblies - Design qualification and type approval
JRC ISPRA 503 [1]	Qualification Test Procedures for Crystalline Silicon Photovoltaic Modules
IEEE 1513	Recommended practice for qualification of concentrator photovoltaic modules
ASTM E1038	Standard Test Method for Determining Resistance of Photovoltaic Modules to Hail by Impact with Propelled Ice Balls
ASTM E1171	Standard Test Method for Photovoltaic Modules in Cyclic Temperature and Humidity Environments
ASTM E1462	Standard Test Methods for Insulation Integrity and Ground Path Continuity of Photovoltaic Modules
ASTM E1596	Test Methods for Solar Radiation Weathering of Photovoltaic Modules
ASTM E1597	Standard Test Method for Saltwater Pressure Immersion and Temperature Testing of Photovoltaic Modules for Marine Environments
ASTM E1799	Standard Practice for Visual Inspections of Photovoltaic Modules
ASTM E1802	Standard Test Methods for Wet Insulation Integrity Testing of Photovoltaic Modules
ASTM E1830-09	Standard Test Methods for Determining Mechanical Integrity of Photovoltaic Modules
ASTM E2047	Standard Test Method for Wet Insulation Integrity Testing of Photovoltaic Arrays
ASTM E2236	Standard Test Methods for Measurement of Electrical Performance and Spectral Response of No concentrator Multifunction Photovoltaic Cells and Modules
ASTM E2481	Standard Test Method for Hot Spot Protection Testing of Photovoltaic Modules
UL 1703	Standard for Flat-Plate Photovoltaic Modules and Panels
IEC 60364-7-712	Electrical installations of buildings - Part 7-712: Requirements for special installations or locations - Solar photovoltaic (PV) power supply systems
IEC 61727	Photovoltaic (PV) systems - Characteristics of the utility interface
IEC 61683	Photovoltaic systems - Power conditioners - Procedure for measuring efficiency
IEC 62093	Balance-of-system components for photovoltaic systems - Design qualification natural environments
IEC 62116	Test procedure of islanding prevention measures for utility-interconnected photovoltaic inverters
IEC 62446	Grid connected photovoltaic systems - Minimum requirements for system

	documentation, commissioning tests and inspection
EN 50524	Datasheet and nameplate information of photovoltaic inverters
IEC 62109-1	Safety of power converters for use in photovoltaic power systems - Part 1: General requirements
IEC 62109-2	Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters
IEC 61683	Photovoltaic systems - Power conditioners - Procedure for measuring efficiency
EN 50530	Overall efficiency of grid connected photovoltaic inverters
UL 1741	Standard for Inverters, Converters, and Controllers for Use in Independent Power Systems

GLASS	
EN 410	Glass in building - Determination of luminous and solar characteristics of glazing
EN 356	Glass in building - Security glazing - Testing and classification of resistance against manual attack
EN 673	Glass in building - Determination of thermal transmittance (U value) - Calculation method
EN 572-1	Glass in building - Basic soda lime silicate glass products - Part 1: Definitions and general physical and mechanical properties
EN 572-2	Glass in Building - Basic soda lime silicate glass products - Part 2: Float glass
EN 572-5	Glass in Building - Basic soda lime silicate glass products - Part 5: Patterned glass
EN 572-8	Glass in building - Basic soda lime silicate glass products - Part 8: Supplied and final cut sizes
EN 572-9	Glass in building - Basic soda lime silicate glass products - Part 9: Evaluation of conformity/Product standard
EN 1748-1-1	Glass in building - Special basic products -Borosilicate glasses Part 1.1:Definition and general physical and mechanical properties
EN 1748-2-1	Glass in building - Special basic products - Glass ceramics Part 2-1 Definitions and general physical and mechanical properties
EN 1748-1-2	Glass in building - Special basic products - Borosilicate glasses Part 1-2: Evaluation of conformity/Product standard
EN 1748-2-2	Glass in building - Special basic products - Glass ceramics Part 2-2: Evaluation of conformity/Product standard
EN 13024-1	Glass in building - Thermally toughened borosilicate safety glass Part 1: Definition and description
EN 13024-2	Glass in building - Thermally toughened borosilicate safety glass Part 2: Evaluation of conformity/Product standard
EN 12600	Glass in building - Pendulum test - Impact test method and classification for flat glass
EN 1288-1	Glass in building - Determination of the bending strength of glass

	Part 1: Fundamentals of testing glass
EN 1288-2	Glass in building - Determination of bending strength of glass Part 2: Coaxial double ring test on flat specimens with large test surface areas
EN 1288-3	Glass in building - Determination of the bending strength of glass Part 3: Test with specimen supported at two points (four point bending)
EN 1288-4	Glass in building - Determination of the bending strength of glass Part 4: Testing of channel shaped glass
EN 1288-5	Glass in building - Determination of the bending strength of glass Part 5: Coaxial double ring test on flat specimens with small test surface areas
EN 14449	Glass in building - Laminated glass and laminated safety glass - Evaluation of conformity/Product standard
ISO 3585	Borosilicate glass 3.3 – Properties
ISO 16293-1	Glass in building -- Basic soda lime silicate glass products Part 1: Definitions and general physical and mechanical properties
ISO 12543-1	Glass in building -- Laminated glass and laminated safety glass Part 1: Definitions and description of component parts
ISO 12543-2	Glass in building -- Laminated glass and laminated safety glass Part 2: Laminated safety glass
ISO 12543-3	Glass in building -- Laminated glass and laminated safety glass Part 3: Laminated glass
ISO 12543-4	Glass in building -- Laminated glass and laminated safety glass Part 4: Test methods for durability
ISO 12543-5	Glass in building -- Laminated glass and laminated safety glass Part 5: Dimensions and edge finishing
ISO 12543-6	Glass in building -- Laminated glass and laminated safety glass Part 6: Appearance
ASTM C1172	Standard Specification for Laminated Architectural Flat Glass
ASTM F1233	Standard Test Method for Security Glazing Materials And Systems

STRUCTURE	
EN 1991-1-2	Eurocode 1: Actions on structures - Part 1-2: General actions - Actions on structures exposed to fire
EN 1991-1-3	Eurocode 1 - Actions on structures - Part 1-3: General actions - Snow loads
EN 1991-1-4	Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions
EN 573-1	Aluminium and aluminium alloys - Chemical composition and form of wrought products - Part 1: Numerical designation system
ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
EN 10088-1	Stainless steels - Part 1: List of stainless steels
EN 10088-2	Stainless steels - Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes

EN 10088-3	Stainless steels - Part 3: Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes
EN 10027-1	Designation systems for steels - Part 1: Steel names
EN 10027-2	Designation systems for steels - Part 2: Numerical system

MONITORING	
IEC 61724	Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis
IEC 61850-7	Communication networks and systems for power utility automation - Part 7-420: Basic communication structure - Distributed energy resources logical nodes
IEC 60870	Telecontrol equipment and systems

Project funded by the EUROPEAN UNION

ENPI CBCMED
CROSS-BORDER COOPERATION IN THE MEDITERRANEAN

DIDS LIT-PB

Egyptian Association for

Energy and Environment (EAEE)

P1. **DESCRIPTION REPORT**

1. Building Integrated Photovoltaic

1.1. Introduction

The Egyptian Association for Energy and Environment (EAEE) is implementing a project funded by the European Union-ENPI CBCMED-cross border cooperation at the Mediterranean, titled " Developing and Implementing Decentralized Innovative Solar Energy Technologies in Public Building (DIDSOLIT-PB) " where as the project aims to :

- Transfer up-to-date- solar energy uses technologies
- Transform the governorate's public buildings into energy saving buildings through the installation of developed solar systems that generate energy of total capacity of 79.2 Kw to be used in lighting and air-conditioning
- Provide technical support and create new expertise in the field of solar energy technology.

The growing concern for the use of renewable energies and the reduction of CO2 emissions of the society has led the Public Administrations to promote Projects regarding alternative energy sources.

Photovoltaic solar energy presents itself as a clean and environmentally friendly alternative. In addition, it has the advantage, due to its morphology, of being easily integrated in urban environments, where most of the demand and energetic consumption is concentrated.

This document intends to structure a constructive guide that includes the principal design criteria, in terms of a standardized implementation, and helps to implement photovoltaic systems in diverse socioeconomic environments, like those situated in the Mediterranean basin countries.

1.2 Solar photovoltaic energy integrated in buildings

1.2.1 Advantages of the system

- A clean, silent and eco-friendly source of power.
- Solar modules convert sunlight into electricity and store it in batteries.
- Negligible maintenance as there are no moving parts.

- Long life span of solar modules.
- Modular design.
- Simple installation: can be mounted on roof tops or the ground.
- Can be installed at point-of use to avoid transmission losses.

1.2.2 System Diagram Block

Low Voltage system diagram bloc:

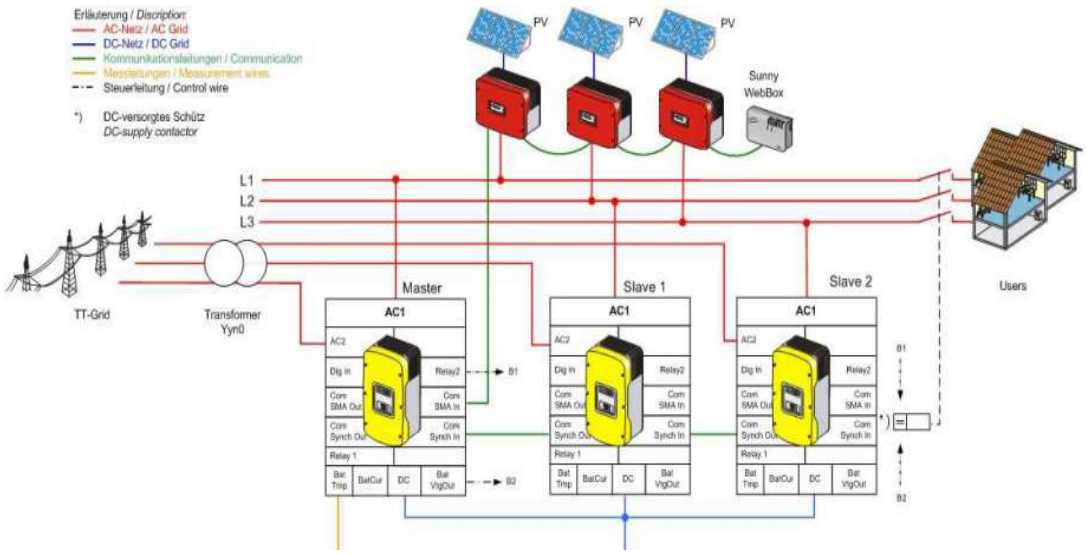


Figure 1 System diagram bloc

1.3. System working principle

1.3.1 Self-Consumption

The rate of self-consumption refers to the share of solar energy that is used directly in the home or indirectly through intermediate storage. The higher the self-consumption rate, the better it is for the PV system's ideal operational conditions.

Since the feed-in compensation for solar power is clearly less than the typical household electricity tariff, it makes sense to use as much solar energy as possible for yourself and feed as little as possible into the utility grid. This makes you less dependent on energy suppliers and rising electricity prices. The intermediate storage of PV power increases the self-consumption rate by creating a reserve supply of solar power for use in the evening and at night.

1.3.2. Self-Consumption with Zero Injection to the Grid

In certain applications, it is forbidden to feed electrical generation back into the grid. This is usually imposed by national regulations and legislation and, as of this writing, it is the situation in Greece and Spain. Additionally, in some other countries there is "feed in" legislation limiting the percentage of generated power that can be fed into the grid, for example in Germany 70% of the inverters maximal power is allowed to be injected in the grid at the coupling point, or 60% of maximal power can be injected by the use of a battery-supported system. It is most likely that this "feed-in limitation" will be adopted by other countries as well.

Market research shows that while "feed-in limitation" or inverter power control is supported by several inverter manufacturers, like the CIRCUTOR CDP System or similar supports zero grid injection. The system is depicted in the diagram below.

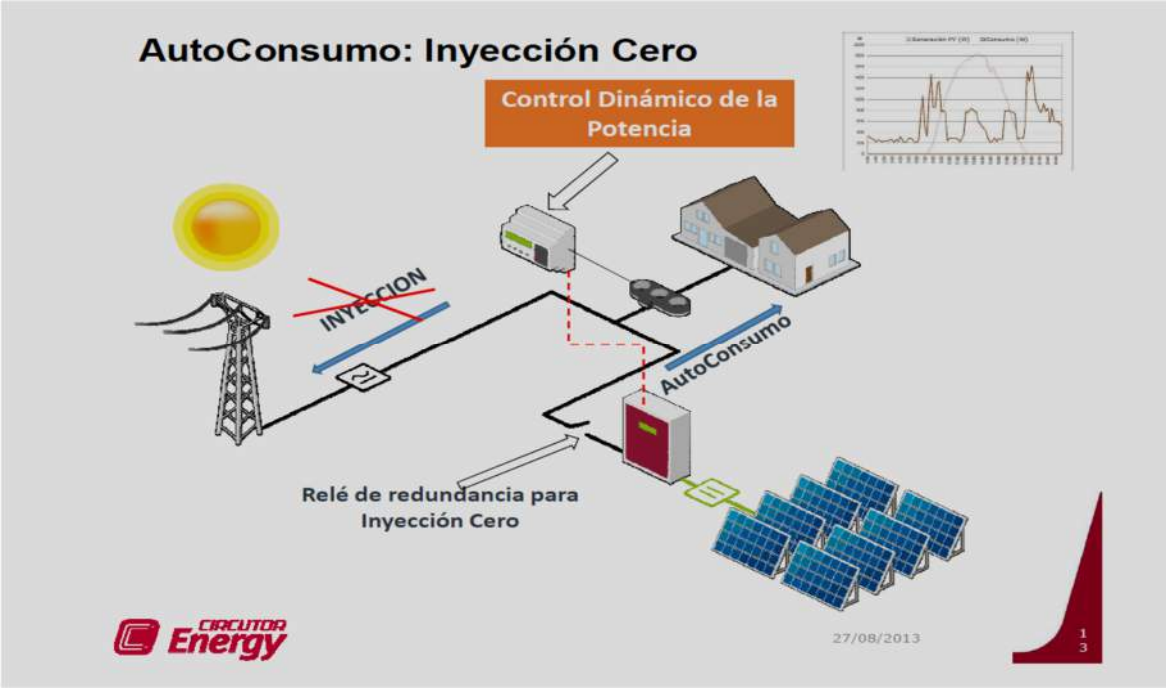


Figure 2 Circutor CDP Scheme Zero Grid injection

The CDP is the main control to prevent electrical energy injection to the grid.
CDP is a dynamic power controller that regulates the inverters generation level based on user consumption. That means it is possible to build a PV system with zero power injection to the mains, as it is required in some countries. This system is ideal for buildings with daytime electricity consumption.
To achieve zero injection, the CDP permanently measures the current and voltage of the load and sends the Fronius inverter periodic command to limit its power in percentage of the inverters nameplate power to the same value.

Circutor offers two different versions of the CDP system: CDP-0 and CDP-G. The CDP-G model includes load management, while the CDP-0 prevents power injection.

The main features of the CDPS are the following:

- CDP -0 / CDP- G is a family of controllers' power dynamic displacement working point of the solar field, which allows for regulating the level of investor generation function user consumption.
- One of the main characteristics of this series is the possibility of measuring all energy flows in a facility: Energy consumed by the user; the energy generated by the inverter; the energy consumed or fed into the grid; the power of an auxiliary generation.
- These devices have to configure power inverter and through a communication channel.
- The CDP is able to adapt the generation of energy for self-consumption, with the objective that the injection to the grid is zero.
- The CDP generates a database with all the information the power and the energy of each point measure. In addition, it includes the percentage of control the inverter allows for monitoring online via the Internet.

Figure 3 CDP Control Zero Grid Injection & SCADA Solution Data logger

To below can see photovoltaic grid connection devices, with RS485 communication channel.

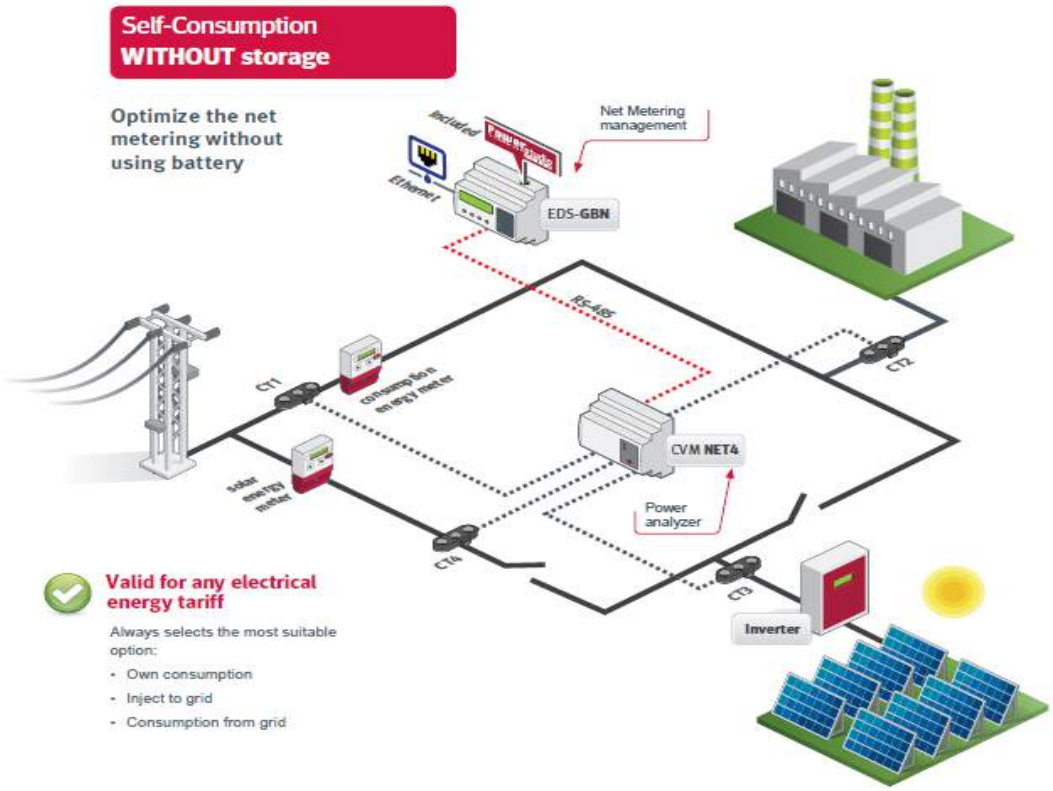


Figure 4 Conceptual Scheme of CDP Diagram Connection.
Power connection & MBUS Connection

1.3.3. Inverters

A solar inverter, or PV inverter, converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network. It is a critical component in a photovoltaic system, given that it allows for the solar panel energy to be used by ordinary commercial appliances.

Solar inverters have special functions adapted for use with photovoltaic arrays, including maximum power point tracking and anti-islanding protection.

It is important for this project that the inverter communicates with the CDP (Control) or a similar one, to activate or de-activate the photovoltaic strings with the aim of zero grid injection.

1.3.4. Classification

Solar inverters may be classified into three broad types:

- **Stand-alone inverters**: these are used in isolated systems where the inverter draws its DC energy from batteries charged by photovoltaic rays. Many stand-alone inverters also incorporate integral battery chargers to replenish the battery from an AC source, when available. Normally, these do not interface in any way with the utility grid, and as such, are not required to have anti-islanding protection.
- **Grid-tie inverters**: these match phase with a utility-supplied sine wave. Grid-tie inverters are designed to shut down automatically upon loss of utility supply, for safety reasons. They do not provide backup power during utility outages.
- **Battery backup inverters:** these are special inverters which are designed to draw energy from a battery; to manage the battery charge via an onboard charger; and, to export excess energy to the utility grid. These inverters are capable of supplying AC energy to selected loads during a utility outage, and are required to have anti-islanding protection.

For this project, the inverter application is the second one, without photovoltaic grid injection.

1.3.5. Protections (Anti islanding protection)

In the event of a power failure on the grid, it is generally required that any grid-tie inverters attached to the grid turn off for a short period of time. This prevents the inverters from continuing to feed power into small sections of the grid, known as "islands". Powered islands present a risk to workers who may expect the area to be unpowered. Equally important is the fact that without a grid signal to synchronize to, the power output of the inverters may exceed the tolerances required by the customer's equipment connected within the island.
Detecting the presence or lack of a grid source would appear to be simple, and in the case of a single inverter in any given possible physical island (between disconnects on the distribution lines for instance) the chance that an inverter would fail to notice the loss of the grid is effectively zero. However, if there are two inverters in a given island, things become considerably more complex. It is possible that the signal from one can be interpreted as a grid feed from the other, and vice versa, so both units continue operation. As they track each other's output, the two can move away from the limits imposed by the grid connections, say in voltage or frequency.

2. Site Description

EAEE has signed a cooperation protocol with The Governorate of Matrouh where it is agreed that PV solar systems will be installed on 4 public buildings in Matrouh city located 450 km north west of Cairo. The total PV power is 79.2 Kw distributed as following :

1. Matrouh Governorate building, 44.2KW, Poly Crystalline panels
2. M.E.I.L.S. Language school, 5KW, Poly Crystalline panels
3. General hospital of Matrouh: 20 KW, thin film panels
4. General library, 10KW, flexible thin film panels

The description of the sites and locations , details and specifications are given in details in Part 2 of this document titled "Drawings and Schemes). Below you can find a summary of the four selected public buildings.

Buildings data

Building 1 : Matrouh Governorate

- Location: El Cornish Street, Matrouh
- Ownership: Governorate of Matrouh
- Use: Offices
- Building surface: 3.200 m^2 (approx.)
- Electricity consumption: 525.000 kWh(approx.)

Building 2: MEILS Language School

- Location: El Cornish Street, Matrouh
- Ownership: Governorate of Matrouh
- Use: Offices, labs
- Building surface: 1.240 m^2 (approx.)
- Electricity consumption: 23.623 kWh (approx.)

Building 3: Matrouh General Hospital

- Location: Alexandria Street , Matrouh
- Ownership: Governorate of Matrouh
- Use: Health care centre
- Building surface: 11.520 m^2 (approx.)
- Electricity consumption: 978.276 kWh (approx.)

Building 4: Matrouh Public Library

- Location: El Cornish Street, Matrouh
- Ownership: Governorate of Matrouh
- Use: Culture center
- Building surface: 1.300 m^2 (approx.)
- Electricity consumption: The library will be inaugurated on Sep.2014

General Description of the Systems

The use of photovoltaic solar energy is through the direct and immediate transformation of the radiation from the sun into electrical energy using the "photovoltaic effect". This transformation is carried out in the so-called "solar cells" that are made from semiconductor material, mostly silicon. When sunlight strikes the cell, photons transmit their energy to electrons of semiconductor material that jump in the pool, thus generating an electric current capable of driving an external circuit. Photovoltaic modules are composed of photovoltaic cells electrically joined together.

PV modules produce DC energy which has to be transformed to AC current, in order to be consumed or evacuated to the public grid. The maximum power that can supply a module in standard conditions is called peak power (Wp). However, the final energy performance ratio will be determined by the PV system design and the environmental and location outputs.

Photovoltaic energy is characterized by being clean, long lasting, requiring low-maintenance, offering high reliability, and is environmental friendly.

The PV installation is divided in five sub systems:

- **Photovoltaic Generator:** This is the heart of the installation, where the conversion of solar energy into electrical energy takes place. The camp consists of photovoltaic interconnection in series and parallel for a number of photovoltaic modules. The generator or photovoltaic plant produces DC.

- **Power Conditioning. Inverters:** These are electronic devices that transform DC power from PV modules into Alternating Current, adapted to the voltage and frequency on the grid. Thus, the photovoltaic system can operate in parallel with the grid. The plant incorporates a system for management and data acquisition that allows a remote monitoring by the inverters, in order to visualize the operation and performance of the installation via a PC, GSM or landline. It can also detect any abnormalities in real time, giving a fast answer.

- **Power Control. Inverters**: List of inverter could operate with Circutor CDP Control self consumption.

- **Protections:** This part represents and constitutes a configuration of elements that act as interface connection between the photovoltaic system and grid security under conditions suitable for both people and for the various components that comprise it. Therefore, protections are required in accordance with the terms of connecting photovoltaic systems following low voltage grid, ISO & IEC norms.

The concept of Photovoltaic Integration refers to the reformulation of architectural elements by replacing conventional constructive materials for energy generator systems, through photovoltaic technologies.

This guide analyses four types of integration, taking into account that these are the most effective and easily standardizable types:

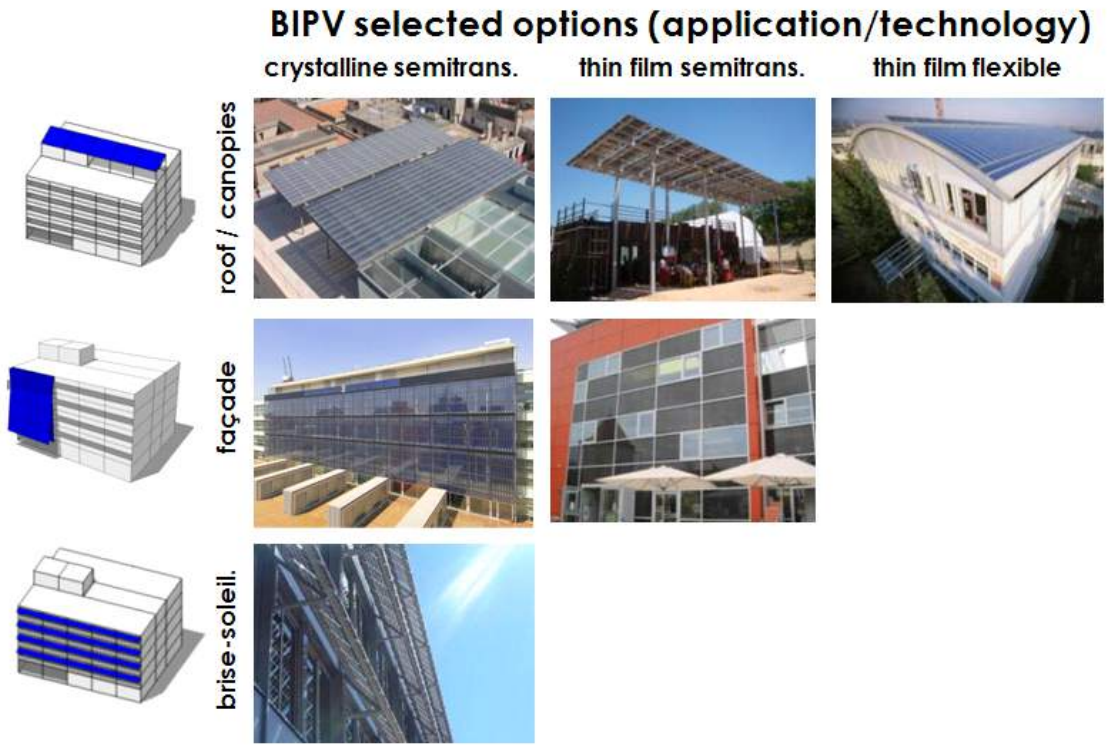


Figure 5 BIPV Selection options

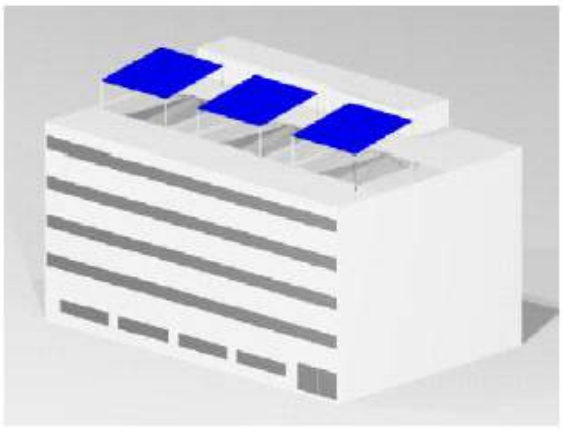


Figure 6 Flat Pergola

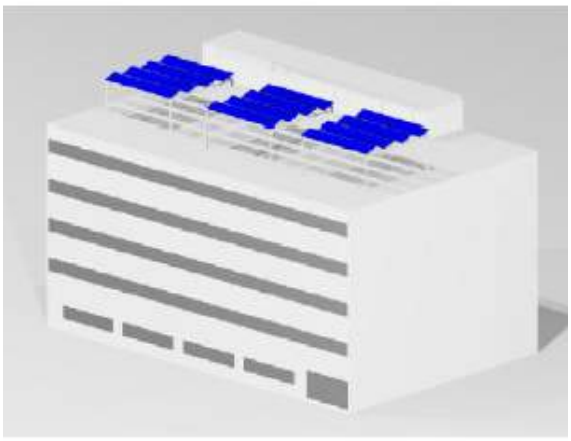


Figure 7 Sow Tooth Pergola

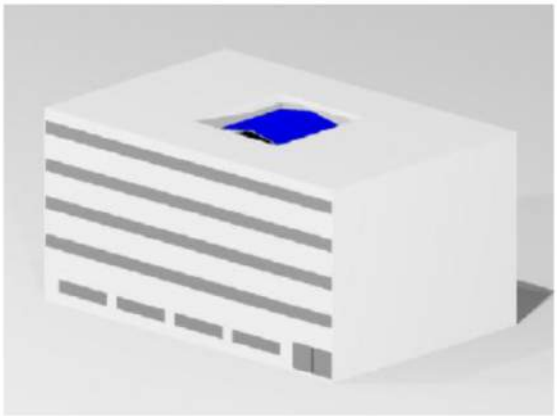


Figure 8 Skylight

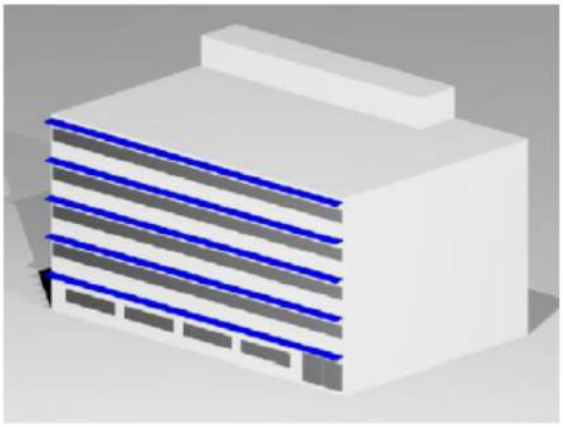


Figure 9 Brise Soleil

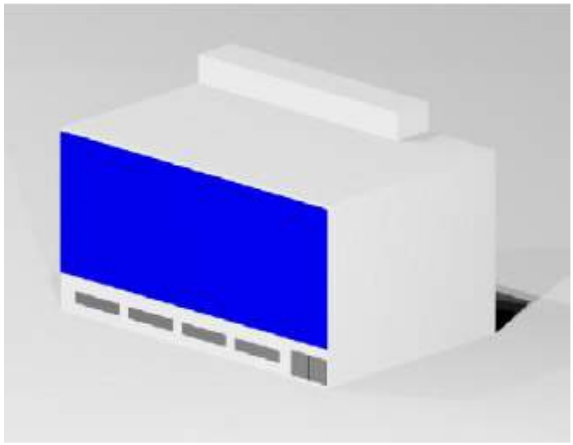


Figure 10 Façade

3. General System

The design of the proposed PV systems installed on the four public buildings are detailed in the engineering attached drawings in P2..

The general graph information for each building that the study has to include is the following:

- Detailed PV system
- Detailed cables Routes AC&DC
- Detailed roof floor
- Detailed structure
- Detailed PV simulation (shadows simulation)
- Detailed PV Room, box and connection location (plan Drawing)

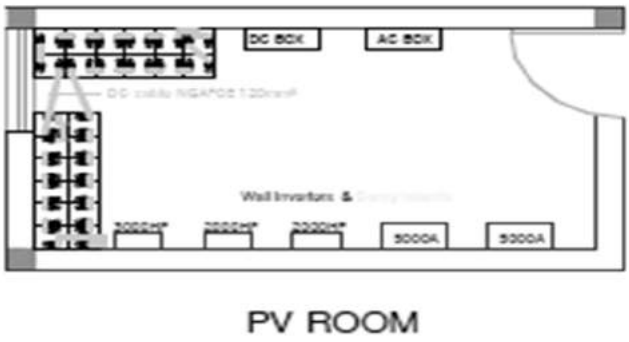


Figure 11Example PV Room
Detail devices location, box location and connection map

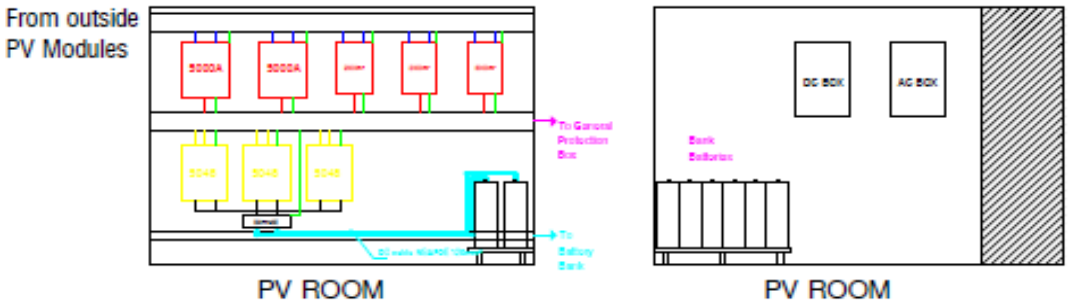


Figure 112 Example PV Room
Detail devices location, box location and connection map

4 System's Components

4.1. Photovoltaic module

PV modules convert solar energy into electrical energy. They consists of solar panels and these, in turn, are composed of several identical interconnected cells electrically in series and/or in parallel, so that the voltage and current supplied by the panel is increased and adjusted to the desired value.
Most of the solar panels are constructed first by combining cells in series to achieve the desired voltage level, and then by combining parallel multiple numbers of cells to achieve the desired current level associations. In addition, the panel has other elements of solar cells, which enable adequate protection set to external agents for ensuring sufficient rigidity, the clamping to the supporting structures and the electrical connection.
Among all the possible technologies, DIDSOLIT-PB project has focused its research and implementation in three different technologies for building integration:

- Semitransparent Silicon (approx. 35% transparency)
- Semitransparent thin film, a-Si (10-20% transparency)
- Flexible thin film, a-Si (opaque)

Module and Cell Efficiency									
Technology	Thin Film					Crystalline Silicon			
	(a-Si)	(CdTe)	CI(G)S	a-Si/ µSi	Semitransparent a-Si (10-20%)	Mono	Multi	Semitransparent Silicon (35%)	
Cell efficiency	4-7%	8-10%	7-11%	6-8%	6-8%	16-22%	14-16%	16-22%	14-16%
Module efficiency						13-19%	12-15%	13-19%	12-15%
Area Needed per kW Power / m²	~ 15 m² 66 Wp/m²	~ 11m² 90 Wp/m²	~ 10m² 100 Wp/m²	~12m² 83 Wp/m²	~ 16 m² 50-60 Wp/m²	~7m² 140 Wp/m²	~8m² 125 Wp/m²	~11 m² 90-100 Wp/m²	

Source based on EPIA 2010 , Photon International + own elaboration

Table 1 Photovoltaic technologies

Even though nowadays the Crystalline technology is absolutely dominant in the PV market, due to its high efficiencies and production costs reductions, thin film technologies, specifically the integrated ones, have also been taken into consideration due to their integration potential.

Thin film technologies offer less performance and therefore require almost double surface to install the same amount of power. However, thin film semi transparency might offer extraordinary integration potential, in terms of visual and light properties of the envelope.

Flexible thin film is suffering a strong loss of market share, mainly due to the more competitive prices of crystalline technologies that are lower in efficiency and lack providers.

However, this light and flexible application, still presents some advantages (material with: static loads, cost and environmental impacts) that might be capitalized in the future, with new PV technologies such as organic or semi-organic cells.

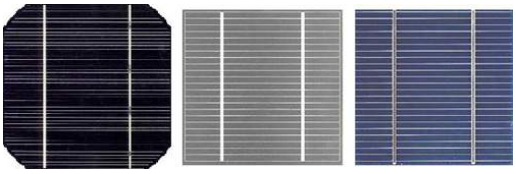


Figure 2: Examples of monocrystalline solar cells (6')

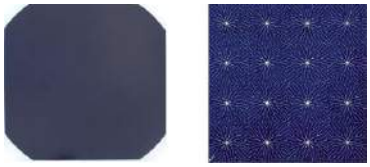


Figure 3: Example of monocrystalline back-contact cell (6')

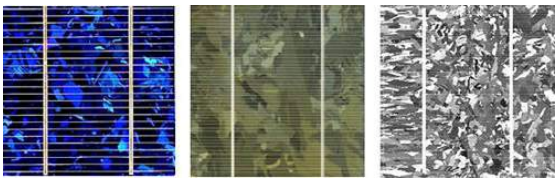
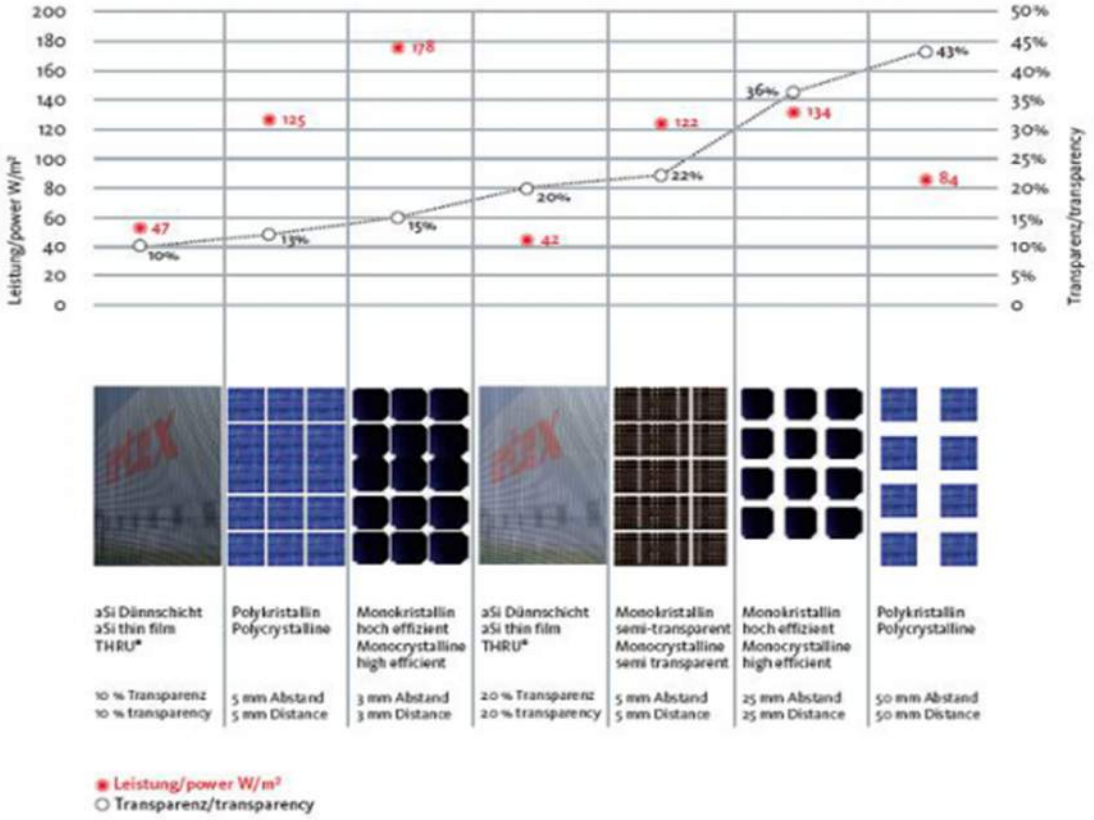


Figure 4: Examples of polycrystalline solar cells (6')

Figure 5: Polycrystalline back-contact solar cell (example) (6')

Figure 6: Examples of thin-film cells

Table 2 Installed power/ m².
According technologies (crystalline and thin film a-SI) and transparency. Source: ertex solar 2009



Essentially, Building Integrated Photovoltaic (BIPV) refers to photovoltaic cells and modules which can be integrated into the building envelope as part of the building structure, and therefore can replace conventional building materials, rather than

being installed afterwards. BIPV modules can be naturally blended into the design of the building and form part of the building envelope.

The extra costs of Building-integrated PV modules (BIPV) might be compensated by their replacing other conventional products (roofing, facades and canopies) and by providing some of the same conventional **properties**, such as:

- **Water tightness (façade, roof, skylight, pergola)**

The water tightness comes not only from the glass properties, but especially from the mounting system that integrates it.

-Semitransparent surfaces: PV glass laminated layer

-Opaque surfaces: Standard PV modules: glass laminated, glass + tedlar, EFTE.

- **Thermal insulation (façade, roof, skylight)**

In most of the climates, building envelope glazing units have to 26ulfil certain insulation requirements. Glass laminated PV modules can be part of insulated glazing units that perform in the same way that a standard glaze should.

- **Sun protection** (façade, roof, skylight, pergola –roof / ground mounted-car sherter)

- Semitransparent surface: (glazed surface: semi transparency-solar factor; shading devices: brise-soleils, canopies, pergolas, etc)

Solar modules can be opaque or semitransparent. In *mono-* or *polycrystalline* modules, the spacing between cells and to the edge can be modified so as to allow variation of shadowing and transparency. In *thin-film modules*, additional cuts perpendicular to the cell strips create a semitransparent effect. Because semitransparent modules absorb less light, they are less efficient per unit of area. Therefore, performance diminishes with increasing translucency.

Main **technical parameters** to be checked, depending on the project requirements:

- **Construction requirements:** thermal insulation, semi-transparency

- **Size**

Depending on the project requirements, a certain degree of dimensional flexibility might be required. Standard dimensions might not be suitable in some cases.

Thin film modules production process has strict rules regarding standard dimensions.

Crystalline laminated modules have much more flexibility.

- **Glass composition and thickness**

The substructure system, its position in the building (façade, roof, etc) and modulation will determine the static loads and glass composition requirements.

Glass laminator and/or PV module provider should advise for the most suitable solution in each case.

PVB lamination foils have been traditionally the only ones accepted for BIPV in Europe, for safety reasons (elasticity coefficient).

Glass thickness ranges from 4+4 to 6+6, depending on glass dimensions and static (snow, maintenance…) and dynamic loads (wind).

- **Transparency**

Depending on the sun protection and natural lighting requirements, the PV module transparency might range from 10% to 40%. Crystalline modules, due to the cell's composition, are much more flexible in terms of transparency options.

4.1.1 Crystalline silicon technology

Crystalline silicon cells are made from thin slices cut from a single crystal of silicon (mono-crystalline) or from a block of silicon crystals (polycrystalline). Their efficiency ranges between 12% and 20%. It is the most common technology, representing about 90% of the current market.

Two main types of crystalline cells can be distinguished.

- Mono-crystalline (Mono c-Si)
- Polycrystalline (or Multi-crystalline) (multi c-Si)

The standard size is 6' (156 mm), although 5' and perforated cells are available in some cases.

Laminated glass modules-technical parameters:

- **Construction requirements:** thermal insulation, semi-transparency
- **Size**

Depending on the project requirements, a certain degree of dimensional flexibility might be required. Standard dimensions might not be suitable in some cases.

Crystalline laminated modules have much more flexibility.

Global dimensions will depend on the lamination capacity of the provider and the modularity of the cells: Starting from 480 x 1475 mm; 720 x 1600 mm; 850 x 1650 mm; 1200 x 1800 mm, are typical optimized dimensions. However, the maximum available dimensions will depend on the glass lamination capacity of the manufacturer: 1600 x 2600 mm; 2100 x 3100 mm; etc.

- **Glass composition and thickness**

The substructure system, its position in the building (façade, roof, etc) and modulation will determine the static loads and glass composition requirements.

A glass laminator and/or PV module provider should provide advice about the most suitable solution in each case.

PVB lamination foils have been traditionally the only ones accepted for BIPV in Europe, for safety reasons (elasticity coefficient).

Glass thickness ranges from 4+4 to 6+6, depending on glass dimensions and static (snow, maintenance…) and dynamic loads (wind).

- **Transparency**

The PV module's transparency depends on the sun protection and natural lighting requirements.

The distance between cells (about 1-2-4-6 cm, depending on the ribbons direction) will determine the PV module transparency (10-40%).

The standard transparency, which is about 35%, leads to installed power ratios of approximately 90-100 Wp/m^2.

Opaque crystalline modules can increase significantly the installed power ratios, till 140-180 Wp/m^2, depending on the technology.

- **Junction box**

Crystalline laminated modules can easily adapt both back and lateral junction boxes.

Lateral junction box might be a good solution to hide all the cabling and connections inside the secondary substructure, such as aluminum or steel profiles and caps.

Glass composition and junction box examples:

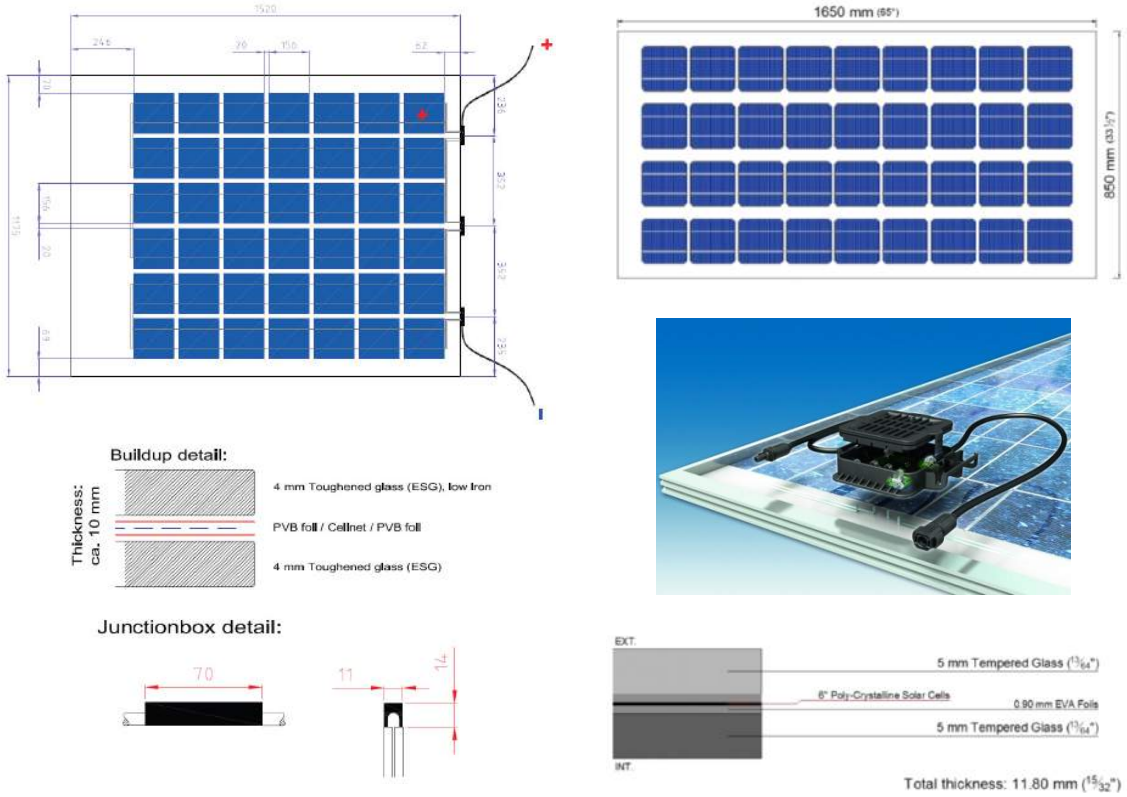


Figure 12 Lateral and back junction box (and security diodes)

Glass Laminated Semitransparent Crystalline Modules	
Project name and location:	
Number of PV module units (approx.)	
System size (approx.)	
Technology	Glass/Glass laminate
Glass composition	*Front pane:* Tempered glass (4/5) mm *PV active glass:* PVB foils *Rear pane:* Tempered glass (4/5) mm
Encapsulant	*Option A*: 2 x 0.76 mm PVB (Polyvinyl butyral) *Option B:* 1.8 mm EVA (Ethylene vinyl acetate)
Total thickness	9.5 mm or 11.8 mm
Size	**1544 x 709 mm**
Weight	21 - 31 kg
Transparency (%)	12 - 24 %
Module efficiency	10 - 20 %
Type of cells	Polycrystalline 156 x 156 mm
Number of cells	36

Distance between PV cells	5-10 mm
Junction box	Edge or Back terminal junction box 2.5 mm^2 or 4 mm^2 wiring section Connectors MC3 or MC4 Bypass diodes for shadow tolerance Protection IP65
Mounting (frame)	No frame Polished edges To be integrated in substructural system
Electrical parameters (STC) 1000 W/m^2	
Nominal power Pnom (approx)	**140-144 Wp**
Power / m^2	128-132 Wp/m^2
Rated Voltage [V_{MPP}]	17.67-18.50 V
rated Current [I_{MPP}]	7.56-8.12 A
Open circuit voltage [V_{oc}]	22.00-22.72 V
Short circuit current [I_{SC}]	8.04-8.42 A
Max. System voltage	1.000 V
Electrical protection class	Class II
Quality and Safety	
Tested according	EN 14449, EN 12150, EN 12600, EN 12543,1-6
Designed and produced according	EN 61215, EN 61730
Certificates	TÜV certificate Origen certificate
Warranty	2 year product guarantee 10 year on power output at 90% 20 years on power output at 80%
Conditions	
Packaging and transportation costs	Estimation
Delivery time	8-10 weeks

4.1.2 Glass laminated Thin Film technology

Thin film modules are constructed by depositing extremely thin layers of photosensitive materials onto a low-cost backing such as glass, stainless steel or plastic.

Thin Film manufacturing processes result in lower production costs compared to the more material-intensive crystalline technology, a price advantage which is counterbalanced by lower efficiency rates (from 5% to 13%). However, this is an average value and all Thin Film technologies do not have the same efficiency.

Four types of thin film modules (depending on the active material used) are commercially available at the moment:

- Amorphous silicon (a-Si) (5-7%)

- Cadmium telluride (CdTe) (9-10%)
- Copper Indium/gallium Diselenide/disulphide (CIS, CIGS) (10-13%)
- Multi junction cells (a-Si/m-Si)

Although CdTe, CIS, CIGS modules might reach higher efficiency than a-Si ones, silicon has the advantage of being easily available in nature.

Thin film have better temperature coefficient, reduction in power output at higher temperatures, than crystalline modules.

Thin-film materials have better out-put in weak light than silicon modules. However, the global performance won't solely depend on the material, but also on the harmonization of the rest of the PV module characteristics.

Laminated glass modules-technical parameters:

- **Construction requirements:** thermal insulation, semi-transparency

- **Size**

Depending on the project requirements, a certain degree of dimensional flexibility might be required. Standard dimensions might not be suitable in some cases.

Thin film modules production process has strict rules regarding standard dimensions.

The manufacture process of the thin film modules is linked to a certain standard dimensions:

Rigid CIS and CdTe standard modules are usually available in set dimensions of 600 x 1200. A-Si modules have a wider range of possible dimensions, although 600 x 1200mm; 1100 x 1300mm are the most common.

The combination of these sub-modules and the subsequent lamination process enlarges the range of possibilities: 600 x 1200mm; 1245 x 635mm; 1242 x 1245mm; 2462 x 635 mm; 1849 x 1245 mm.

- **Glass composition and thickness**

The substructure system, its position in the building (façade, roof, etc) and modulation will determine the static loads and glass composition requirements.

A glass laminator and/or PV module provider should provide advice regards the most suitable solution in each case.

PVB lamination foils have been traditionally the only ones accepted for BIPV in Europe, for safety reasons (elasticity coefficient).

Thin film modules have a particularity that comes from its production process: the a-Si film layer is deposited on a glass sub-base (3.2 mm float glass). In order to obtain the same characteristics of a 5+5mm PVB laminated glass, depending on the dimensions, sometimes it is required a composition of 6T+3.2+6T (T: tempered glass).

This makes glass dimensional flexibility more difficult and costly.

- **Transparency**

The PV module's transparency depends on the sun protection and natural lighting requirements.

The transparency is given by the pattern cut made to the initial deposition.

The resultant "microcells" allow a good visual transparency, even though the global PV module transparency percentage ranges are quite similar to the crystalline ones (10-30%).

The standard transparency of 10% leads to installed power ratios of approximately 44Wp/m2.

Opaque thin film modules can significantly increase the installed power ratios, till 66-110Wp/m2, depending on the technology.

- **Junction box**

Simple laminated thin film modules (not insulated ones) usually integrate small junction boxes (two: one for each pole) in order to simplify the module internal electrical interconnection.

When the PV module requires glass lamination at both sides, the lateral junction box is also available, making the technical solution a bit more complex and costly.

Glass composition and junction box examples:

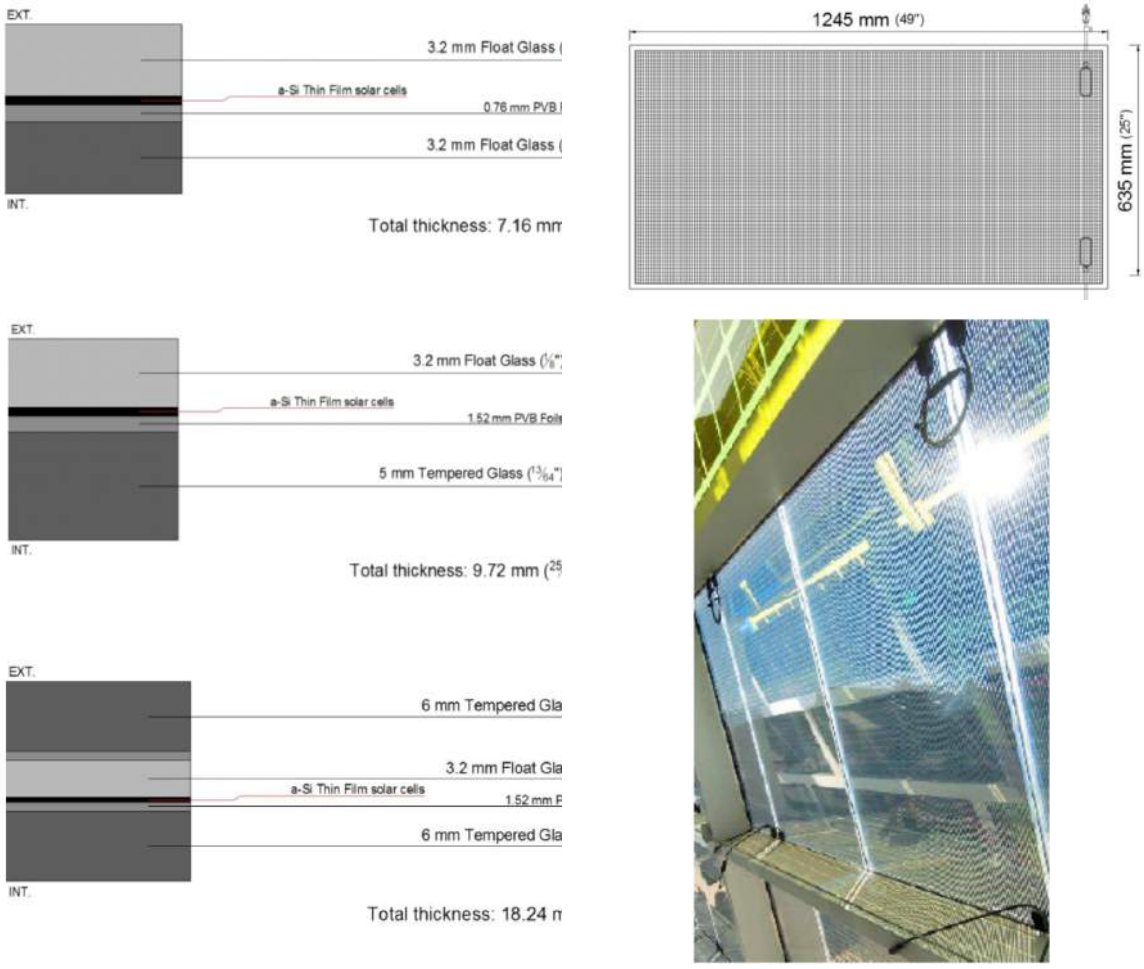


Figure 13 Lateral and back junction box (and security diodes)

Glass Laminated Semitransparent Thin Film Modules	
Project name and location:	
Number of PV module units (approx.)	
System size (approx.)	
Technology	Glass/Glass laminate
Glass composition	*Option 1:* Tempered glass 4 mm Float glass 3.2 mm Tempered glass 4 mm *Option 2:* Float glass 3.2 mm Float glass 3.2 mm
Encapsulant	*Option 1:* 3.04 mm PVB Foils (Polyvinyl butyral) *Option 2:* 0.45 mm EVA Foils (Ethylene vinyl acetate)
Total thickness	7 mm or 12.72 mm
Size	**1300 x 1100 mm**
Weight	24 - 40.1 kg
Transparency (%)	10 - 20 %
Module efficiency	10 - 20 %
Type of cells	a-Si thin film
Junction box	Edge or Back terminal junction box 2.5 mm^2 or 4 mm^2 wiring section Connectors MC3 or MC4 Bypass diodes for shadow tolerance Protection IP65
Mounting (frame)	No frame Polished edges To be integrated in substructural system
Electrical parameters (STC) 1000 W/m^2	
Nominal power Pnom (approx)	**68 - 90 Wp**
Power / m^2	47.55 – 62.94 Wp/m^2
Rated Voltage [V_{MPP}]	73.70 - 103 V
rated Current [I_{MPP}]	0.90 – 0.92 A
Open circuit voltage [V_{oc}]	98.27 - 137 V
Short circuit current [I_{SC}]	1.02 – 1.15 A
Max. System voltage	1.000 V
Electrical protection class	Class II
Quality and Safety	
Tested according	EN 14449, EN 12150, EN 12600, EN 12543,1-6
Designed and produced according	EN 61215, EN 61730
Certificates	TÜV certificate Origen certificate
Warranty	2 year product guarantee 10 year on power output at 90% 20 years on power output at 80%
Conditions	
Packaging and transportation costs	Estimation

Delivery time	8-10	eeks

4.1.3 Laminated flexible Thin Film technology

Based on a similar production process to thin film cells, when the active material is deposited in a thin plastic, the cell can be flexible. This opens the range of applications, especially for Building integration (roofs-tiles) and end-consumer applications.
Thin film cells have better temperature coefficients and offer better reductions in power output at higher temperatures than crystalline modules.
Thin-film materials have better out-put in weak light than silicon modules. However, the global performance won't solely depend on the material, but also on the harmonization of the rest of the PV module characteristics.
For example, the plastic encapsulant roughness might increase the out-put loses due to the dirt accumulation.
These kinds of factors, combined with the module position in the building, should be taken into account when carrying out energy production simulations.

Flexible laminated modules-technical parameters:

- **Construction requirements:**
- **Size**

  Flexible, ductile a-SI modules on high-grade steel strips, laminated in synthetic material (EFTE), currently have a width of 40 cm and a length of up to 6 meters, which can be shortened on request.

Figure 14 Flexible Thin Film

Laminated flexible composition and junction box examples:

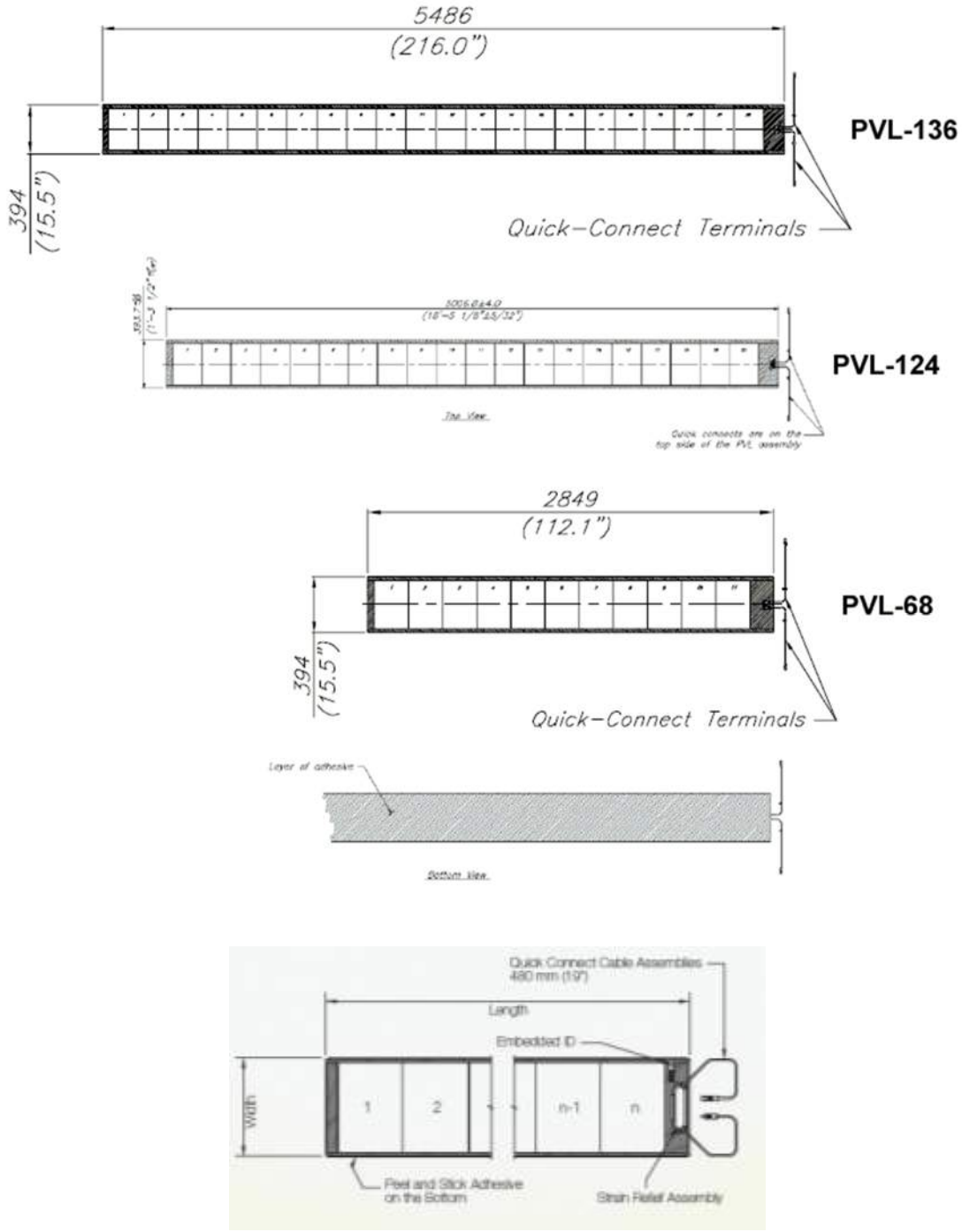


Figure 15 Lateral and back junction box

EFTE Laminated Flexible Thin Film (a-Si) Modules	
Project name and location:	
Number of PV module units (approx.)	
System size (approx.)	
Technology	EFTE laminate flexible / Thin Film
Laminated composition	Polymer on the front side highly transparent and UV and weathering resistant EFTE
Encapsulant	Durable EFTE high light-transmissive polymer
Total thickness	4 mm 16 mm (including junction box)
Size	**5486 x 394 mm**
Weight	7.7 kg
Transparency (%)	0 %
Module efficiency	5 - 10 %
Type of cells	a-Si 356 x 239 mm
Number of cells	22 triple junction connected in series
Junction box	Back terminal junction box 2.5 mm^2 wiring section Connectors MC3 or MC4 Bypass diodes for shadow tolerance Protection IP65
Mounting (frame)	No frame To be integrated in substructural system
Electrical parameters (STC) 1000 W/m^2	
Nominal power Pnom (approx)	**136 Wp**
Power / m^2	62.96 Wp/m^2 (approx.)
Rated Voltage [V_{MPP}]	33 V
rated Current [I_{MPP}]	4.1 A
Open circuit voltage [V_{oc}]	46.2 V
Short circuit current [I_{SC}]	5.1 A
Max. System voltage	1.000 V
Electrical protection class	Class II
Quality and Safety	
Tested according	EN 14449, EN 12150, EN 12600, EN 12543,1-6
Designed and produced according	EN 61215, EN 61730
Certificates	TÜV certificate Origen certificate
Warranty	2 year product guarantee 20 years on power output at 80%
Conditions	
Packaging and transportation costs	Estimation
Delivery time	8-10 weeks

4.2 Inverter selection

A solar inverter converts the direct current generated by the solar panels into the grid by injecting an alternating current. Depending on the installation demands of a system (for example a system's installed power or several solar field orientations), there is a wide variety of commercial inverters suitable for all kinds of every possible scenarios.

There are countless photovoltaic installations worldwide and many companies developing solar inverters around the world. To limit the options in this study, two major European companies are selected: SMA Solar Technology AG (SMA) and Fronius, both global leaders in the development, production and sales of solar inverters.

Two factors are taken under consideration:

- the (sub)system's installed power (2.5kW, 5kW, 10kW, 15kW and 20kW)
- the solar array orientation

Important aspects for investors to take into consideration when choosing an Inverter:

- It must have a high efficiency, as otherwise it will unnecessarily increase the number of panels to power the load
- It must be protected against short circuits and overloads
- Add rearmament and automatic disconnection
- Snapshot support higher power demands 150% of your maximum power
- It must comply with the requirements laid down in Regulation Low Voltage. Decline harmonic distortion
- Low power consumption
- Insulation

In continuation, possibilities of some standard simulations with inverter selections are shown, including system measures and monitoring:

• In a 2.5kW system with unique solar array orientation :
Sunny Boy 2500TL or Fronius IG Plus 25 V-1 could be installed
• In a 5kW system with unique solar array orientation:
Fronius IG TL 5.0 could be installed

• In a 10kW system with unique solar array orientation:
Fronius IG Plus 120V-3 could be installed
• In a 15kW system with unique solar array orientation:
Sunny Tripower 15000TL Economic Excellence could be installed
• In a 20kW system with unique solar array orientation:
Sunny Tripower 20000TL Economic Excellence could be installed
• In a 2.5kW system with more solar array orientations:
Sunny Boy 5000TL could be installed

• In a 10kW system with more solar array orientations:
Sunny Tripower 10000TL could be installed
• In a 15kW system with more solar array orientations:
Sunny Tripower 15000TL could be installed

4.2.1 Unique orientation

4.2.1.1 2.5 kW

Table 1 Sunny Boy 2500TL Single Tracker, Technical Data

SUNNY BOY 2500TL	
INPUT (DC)	
Max. DC power (@ cos φ = 1)	2 650 W
Max. input voltage	750 V
MPP voltage range with a line voltage of 230 V / rated input voltage	180 – 500 V / 400 V
Min. input voltage / start input voltage	125 V / 150 V
Max. input current	15 A
Max. input current per string	15 A
Number of independent MPP inputs / strings per MPP input	1 / 2
OUTPUT (AC)	
Rated power (@ 230 V, 50 Hz)	2 500 W
Max. apparent AC power	2 500 VA
Nominal AC voltage	220 V / 230 V / 240 V
Nominal AC voltage range	180 V – 280 V
AC power frequency / range	50 Hz, 60 Hz / –5 Hz, +5 Hz
Rated power frequency / rated grid voltage	50 Hz / 230 V

Max. output current	10.9 A
Power factor at rated power	1
Displacement power factor, adjustable	0.8 overexcited ... 0.8 under-excited
Feed-in phases / connection phases	1 / 1
EFFICIENCY	
Max. efficiency / European weighted efficiency	97% / 96.0%
PROTECTIVE DEVICES	
DC-side disconnection device	opt.
Ground fault monitoring / grid monitoring	yes / yes
DC reverse polarity protection / AC short-circuit current capability / galvanically isolated	yes / yes / —
All-pole-sensitive residual-current monitoring unit	yes
Protection class (as per IEC 62103) / overvoltage category (as per IEC 60664-1)	I / III
GENERAL DATA	
Dimensions (W / H / D) in mm	490 / 519 / 185
Weight	23 kg / 57.3 lb
Operating temperature range	-25°C ... +60 °C / –13 °F ... 140 °F
Noise emission (typical)	25 dB(A)
Self-consumption (at night)	1 W
Topology / cooling concept	Transformerless / convection
Degree of protection: electronics / connection area (per IEC 60529)	IP65 / IP54
Climatic category (as per IEC 60721-3-4)	4K4H
Maximum permissible value for relative humidity (non-condensing)	100%
FEATURES	
DC connection	SUNCLIX
AC connection	spring clamp terminal
Display	chart
Interfaces: RS485 / *Bluetooth*® / Webconnect / Speedwire	opt. / yes / opt. / opt.
Warranty: 5 / 10 / 15 / 20 / 25 years	yes / opt. / opt. / opt. / opt.
Multi-function relay	opt.
Certificates and approvals (more upon request)	CE, VDE 0126-1-1, VDE-AR-N 4105, C10/11, G83/1-1, G59/2
Certificates and approvals (planned)	RD 1699/2011, PPC, RD 661/2007, AS 4777, EN 50438*, MEA, PPDS, IEC61727, SI4777, UTE C15-712-1

Type designation	SB 2500TLST-21

Table 2 Fronius IG Plus 25 V-1, Technical Data

FRONIUS IG PLUS 25 V-1

INPUT (DC)	
DC max. power for cos φ=1	2,740 W
Max. array short circuit current	17.9 A
Max. input current	11.9 A
Max. input voltage	600 V
MPP voltage range	230 - 500 V
OUTPUT (AC)	
AC nominal output for cos φ=1	2,600 W
Max. output power	2,600 VA
Max. output current	11.3 A
Max. efficiency	95.7 %
Euro. efficiency	94.6 %
MPP adaptation efficiency	> 99.9 %
Grid connection	1~NPE 230 V
Frequency	50 Hz / 60 Hz
Harmonic distortion	< 3 %
Power factor	0.75 - 1 ind./cap
Night consumption	app. 1 W
GENERAL DATA	
Dimensions (height x width x depth)	673 x 434 x 250 mm
Weight	23.8 kg
Degree of protection	IP 54
Inverter concept	HF transformer
Cooling	Regulated air cooling
Installation	Indoor and outdoor installation
Ambient temperature range	from -25°C to +55°C
Permitted humidity	0 % to 95 %
SAFETY EQUIPMENT	
DC insulation measurement	Warning/shutdown (depending on country setup) at Riso < 500 kΩ
Overload behavior	Operating point shift, power limiter
DC disconnect	Integrated
INTERFACES	

Optional with Fronius Datamanager	WLAN, Ethernet, Modbus TCP, 6 digital inputs, 4 digital inputs/outputs, Datalogger, Webserver

4.2.1.2 5kW system

Table 3 Fronius IG TL 5.0, Technical Data

FRONIUS IG TL 5.0	
INPUT (DC)	
DC maximum power	5,250 W
Max. input current	14.7 A
Max. input voltage	850 V
MPP voltage range	350 - 700 V
OUTPUT (AC)	
AC nominal output	4,600 W* / 5,000 W
Max. output power	5,000 W
Max. output current	21.7 A
Max. efficiency	97.7 %
European efficiency	97.3 %
MPP adjustment efficiency	> 99.9 %
Mains connection	1~NPE 230 V
Frequency	50 Hz / 60 Hz
Distortion factor	< 3 %
Power factor	1
Nighttime consumption	ca. 1 W
GENERAL DATA	
Dimensions (H x W x D)	597 x 413 x 195 mm
Weight	19.1 kg
Degree of protection	IP 55
Inverter	Transformerless
Cooling	Controlled air cooling
Installation	Indoors and outdoors
Ambient temperatur range	-20°C to +55°C
Permitted humidity	0 % to 95 %
PROTECTIVE EQUIPMENT	
DC insulation measurement	Universal-current-sensitive fault monitoring
Overload behaviour	Operating point adjustment, power limitation
DC disconnector	Integrated
INTERFACES	
USB A socket	For USB sticks** no bigger than 80 x 33 x 20 mm (L x W x H)
Signalling output (NO contact)	2-pin screw terminal, 12V max. 300 mA
2x RS422 (RJ45 socket)	Fronius Solar Net, interface protocol

4.2.1.3 10kW system

Table 4 Fronius IG Plus 120V-3, Technical Data

FRONIUS IG PLUS 120V-3	
INPUT (DC)	
DC maximum power at cos φ=1	10,590 W
Max. input current	46.2 A
Max. array short circuit current	69.3 A
Max. input voltage	600 V
MPP voltage range	230 - 500 V
OUTPUT (AC)	
AC nominal output at cos φ=1	10,000 W
Max. output power	10,000 VA
Max. output current	14.5 A
Max. efficiency	95.9 %
Euro. efficiency	95.4 %
MPP adaption efficiency	> 99.9 %
Grid connection	3~NPE 400 V / 230 V
Frequency	50 Hz / 60 Hz
Harmonic distortion	< 3 %
Power factor	0.75 - 1 ind. / cap.
Night consumption	app. 1 W
GENERAL DATA	
Dimensions (height x width x depth)	1,263 x 434 x 250 mm
Weight	49.2 kg
Degree of protection	IP 54**
Inverter concept	HF transformer
Cooling	Regulated air cooling
Installation	indoor and outdoor installation
Ambient temperature range	From -25°C to +55°C
Permitted humidity	0 % to 95 %
SAFETY EQUIPMENT	
DC insulation measurement	Warning/shutdown (depending on country setup) at Riso < 500 kΩ
Overload behavior	Operation point shift, power limiter
DC circuit breaker	Integrated
INTERFACES	
Optional with Fronius Datamanager	WLAN, Ethernet, Modbus TCP, 6 digital inputs, 4 digital inputs/outputs, Datalogger, Webserver

4.2.1.4 15kW system

Table 5 Sunny Tripower 15000TL, Technical Data

SUNNY TRIPOWER 15000TL	
INPUT (DC)	
Max. DC power (@ cos φ=1)	15260 W
Max. input voltage	1000 V
MPP voltage range with a line voltage of 230 V/rated input voltage	580 V – 800 V / 580 V
Min. input voltage / start input voltage	570 V / 620 V
Max. input current	36 A
Max. input current per string	36 A
Number of independent MPP inputs / strings per MPP input	1 / 6
OUTPUT (AC)	
Rated power (@230 V, 50 Hz)	15000 W
Max. apparent AC power	15000 VA
Nominal AC voltage	3 / N / PE; 230 / 400 V
Nominal AC voltage range	160 V – 280 V
AC power frequency / range	50 Hz, 60Hz / -6 Hz ... +5 Hz
Rated power frequency / rated grid voltage	50 Hz / 230 V
Max. output current	24 A
Power factor at rated power	1
Displacement power factor, adjustable	0.8 overexcited ... 0.8 underexcited
Feed-in phases / connection phases	3 / 3
EFFICIENCY	
Max. efficiency / European weighted efficiency	98,5 % / 98,3 %
PROTECTIVE DEVICES	
DC-side disconnection device	opt.
Ground fault monitoring / grid monitoring	yes / yes
DC surge arrester (type II), can be integrated	—
DC reverse polarity protection/AC short-circuit current capability/galvanically isolated	yes/ yes/ —

All-pole-sensitive residual-current monitoring unit	yes
Protection class (as per IEC 62103)/overvoltage category (as per IEC 60664-1)	I / III
GENERAL DATA	
Dimensions (W / H / D)	665 / 680 / 265 mm (26,2 / 26,8 / 10,4 inch)
Weight	45kg / 99,2 lb
Operating temperature range	-25 °C ... +60 °C / -13 °F ... 140 °F
Noise emission (typical)	51 dB(A)
Self-consumption (at night)	1 W
Topology / cooling concept	Transformerless / OptiCool
Degree of protection (per IEC 60529)	IP65
Climatic category (as per IEC 60721-3-4)	4K4H
Maximum permissible value for relative humidity (non-condensing)	100 %
FEATURES	
DC terminal	SUNCLIX
AC connection	spring clamp terminal
display	chart
Interfaces: RS485 / *Bluetooth* / Webconnect / Speedwire	opt. / yes / opt. / opt.
Warranty: 5 / 10 / 15 / 20 / 25 years	yes/ opt. / opt. / opt. / opt.
Multi-function relay / Power Control Module	opt. / opt.
Certificates and approvals (more available on request)	CE, VDE 0126-1-1, VDE-AR-N 4105, PPC, RD 661/2007, UTE C15-712-1, EN 50438**, PPDS, RD 1699, AS 4777*, BDEW 2008*, C10/11, CEI 0-21*, G59/2, IEC61727*
Type designation	STP 15000TLEE-10

4.2.1.5. 20kW system

Table 6 Sunny Tripower 20000TL, Technical Data

SUNNY TRIPOWER 20000TL

INPUT (DC)	
Max. DC power (@ cos φ=1)	20450 W
Max. input voltage	1000 V
MPP voltage range with a line voltage of 230 V/rated input voltage	580 V – 800 V / 580 V
Min. input voltage / start input voltage	570 V / 620 V
Max. input current	36 A
Max. input current per string	36 A
Number of independent MPP inputs / strings per MPP input	1 / 6
OUTPUT (AC)	
Rated power (@230 V, 50 Hz)	20000 W
Max. apparent AC power	20000 VA
Nominal AC voltage	3 / N / PE; 230 / 400 V
Nominal AC voltage range	160 V – 280 V
AC power frequency / range	50 Hz, 60Hz / -6 Hz ... +5 Hz
Rated power frequency / rated grid voltage	50 Hz / 230 V
Max. output current	29 A
Power factor at rated power	1
Displacement power factor, adjustable	0.8 overexcited ... 0.8 underexcited
Feed-in phases / connection phases	3 / 3
EFFICIENCY	
Max. efficiency / European weighted efficiency	98,5 % / 98,2 %
PROTECTIVE DEVICES	
DC-side disconnection device	opt.
Ground fault monitoring / grid monitoring	yes / yes
DC surge arrester (type II), can be integrated	—
DC reverse polarity protection/AC short-circuit current capability/galvanically isolated	yes/ yes/ —

All-pole-sensitive residual-current monitoring unit	yes
Protection class (as per IEC 62103)/overvoltage category (as per IEC 60664-1)	I / III
GENERAL DATA	
Dimensions (W / H / D)	665 / 680 / 265 mm (26,2 / 26,8 / 10,4 inch)
Weight	45kg / 99,2 lb
Operating temperature range	-25 °C ... +60 °C / -13 °F ... 140 °F
Noise emission (typical)	51 dB(A)
Self-consumption (at night)	1 W
Topology / cooling concept	Transformerless / OptiCool
Degree of protection (per IEC 60529)	IP65
Climatic category (as per IEC 60721-3-4)	4K4H
Maximum permissible value for relative humidity (non-condensing)	100 %
FEATURES	
DC terminal	SUNCLIX
AC connection	spring clamp terminal
display	chart
Interfaces: RS485 / *Bluetooth* / Webconnect / Speedwire	opt. / yes / opt. / opt.
Warranty: 5 / 10 / 15 / 20 / 25 years	yes/ opt. / opt. / opt. / opt.
Multi-function relay / Power Control Module	opt. / opt.
Certificates and approvals (more available on request)	CE, VDE 0126-1-1, VDE-AR-N 4105, PPC, RD 661/2007, UTE C15-712-1, EN 50438**, PPDS, RD 1699, AS 4777*, BDEW 2008*, C10/11, CEI 0-21*, G59/2, IEC61727*
Type designation	STP 20000TLEE-10

4.3 Low voltage installation

4.3.1 General cables

The cables used shall be of not less than rated voltage 0.6/1kV for power circuits and 450/750V for control circuits.

The minimum outside diameter of the pipe, based on the name and the section of the conductors driving, will be obtained from the tables shown in the local standard reference, and have the minimum characteristics depending on your installation.

For the execution of the pipelines under protective tubes, the following general requirements shall be taken into account:

- The layout of the pipes will be along vertical and horizontal parallel lines or the edges of the walls adjacent to the location where you are installing.
- The tubes are joined together by suitable accessories to ensure continuity of the protection afforded to cables.
- The bendable rigid insulating hot pipes can be assembled together by coating the trunking with special glue when a seal is required.
- The minimum bend radius for each class of conduction shall be as specified by the manufacturer.
- For easy insertion and removal of the wires in the tubes after place and secured them and their accessories supplied for this combiner box to be considered convenient, it will not be in straight sections spaced 15 meters
- The number of curves between two consecutive combiner boxes will not be greater than 3.
- The cables are usually accommodated in the tubes after placing them.
- The combiner boxes may be intended solely to facilitate the introduction and withdrawal of tubes or wires serve as both boxes trunking or referral.
- Connections between conductors are carried boxes inside appropriate material insulating or flame retardant.
- If the connections are metal, they will be protected against corrosion. The dimensions of these boxes will be such to comfortably accommodate all cables needed. Its depth is at least equal to the diameter of the larger wire plus 50%thereof, with a minimum of 40 mm. Or minimum inner diameter side is 60 mm .When you want to make watertight tubes entries in junction boxes shall cable glands used.
- In metal protection pipes for the wires without internal insulation, will take into account the possibility that will produce condensation of water inside , which is why they conveniently choose the layout of the installation, preventing evacuation and establishing a ventilation

appropriate inside the tubes by suitable system, as may be, for example , the use of a "T" of which one of the arms is not used.

- The tubes are fixed to the wall or ceiling using cable ties or clamps protected against corrosion and fastened solidly. The distance between these is a maximum of 0.50 meters. Fixings of the one and the other party to address changes should be provided in the junctions and in the immediate vicinity of the entries in boxes or appliances.
- The tubes are placed on the surfaces adapted to be installed which, curving or using the necessary accessories. - In straight alignments, deviations from the tube axis to the line joining the points ends shall not exceed 2%.
- There should tubes, whenever possible, to a minimum height of 2.5 meters on the ground, in order to protect them from possible mechanical damage.

Solar DC/AC inverters have dc input (dc side) and ac output (ac side). Thus, there are one or more dc circuits including pv arrays, protection devices, solar dc cables and pv connectors. At the output of the inverter, the ac circuit includes mostly ac cables and protection devices**.**

- Electrical installation
- DC side
- DC Cables and PV Connectors

Olflex-Solar XLS DC cables are used to connect solar modules to each other and as an extension cable between each pv array and the inverter's dc input terminals (in cases where the panel cable is not long enough). Solar cables are chosen in order to limit power losses on the cables and voltage drop across the cables. Typically, the conductor's cross section is from 4 to 6mm^2. In addition, cables have to be uv and -if necessary- humidity resistant. Core insulation usually has the same color as the outer sheath: black/black for both positive and negative polarity; however, in order to distinguish string's polarity more easily, core insulation can come in a different color from the outer sheath: red/black for positive polarity and black/black for negative polarity.

Figure 16 Cable Image Example

To connect the cable with the rest of the dc circuit, PV connectors have to be used. In general, pv connectors come in both male and female types which are designed to fit securely together both for conductivity and safety reasons.

Each type of PV module is compatible with one type of PV connectors. The type of PV connector is followed by a certain cross-sectional size of solar dc cable. The most common solar PV connector types are MC4, MC3, TYCO and RADOX by HUBER-SUHNER.

Figure 17 Pair of MC4 PV connectors

Figure 18 Pair of MC3 PV connectors

Figure 19 Pair of TYCO PV connectors

Figure 20 Pair of RADOX PV connectors

4.3.2 DC - Miniature Circuit Breakers (MCBs)

MCBs are designed to protect the cable downstream of the device against overloads and short circuits, preventing damage to cables and equipment. In a PV system on the dc side, MCBs protect strings against dc reverse currents.

Figure 21 MCB's devices

4.3.3 DC - Surge Protective Devices (SPDs)

SPDs protect inverters, arrays, measurement and control equipment, and communication systems from being affected by current surges caused by lightening. SPDs also protect consumers from generated transients. SPDs should be applied to both the DC side and AC side of the inverter. The key location of SPDs helps to protect against damage caused by lightening by either shorting or clamping the voltage, thereby minimizing the transient voltage that would otherwise be present at the equipment terminals.

Some inverter manufacturers also supply such devices either as optional or standard equipment.

Figure 22 SPD's devices

4.3.4 DC - Circuit Breakers

DC circuit breakers are used for coupling or uncoupling of a circuit under load. They are easy to handle when maintenance work needs to be done on the dc side of the inverter.

Figure 23 DC Circuit Breakers devices

4.3.5 AC - Distribution board

The overall enclosure is responsible for safeguarding the entire electrical installation of a short circuit or tip intensity which affects all connected components network. This general enclosure may be worn as a thermal protection fuse.

4.3.6 AC - Miniature Circuit Breakers (MCBs)

MCBs protect strings from ac back-feed caused by a defective inverter.

Figure 24 AC MCB's

4.3.7 AC - Circuit breakers

AC circuit breakers are also used for coupling or uncoupling of a circuit under load. They are easy to handle when maintenance work needs to be done.

Figure 25 AC Circuit Breakers

4.3.8 AC - Residual-Current Device (RCD)

A RCD is an electrical wiring device that disconnects a circuit whenever it detects that the electric current is not balanced between the energized conductors and the neutral conductor. Such an imbalance may indicate current leakage through the body of a person who is grounded and accidentally touching the energized part of the circuit. RCDs protect people from electric shock and the installation from fire. They do not provide protection against overload or all short-circuit conditions. Such devices may be integrated in inverters but special attention has to be paid to RCD current-time tripping sensitivity.

Figure 26 AC Circuit Breakers

4.3.9 Interconnecting photovoltaic installation

It is responsible for connecting the various solar panels with interconnecting boxes and other instrumentation. These wiring panels are made with high quality materials to ensure durability and reliability of the system outdoors.

The wiring must comply with the technical regulations of low voltage. Connections, cables, equipment and other items will have to have the degree of protection IP535 concept defined in the reference Standards.

The cables used will have a final layer of protection with a material resistant to weather and moisture, so they do not affect you internally agents atmospheric.

Among the electrical connections between panels will use always terminal. The terminals of the panels can be terminal in the rear of the panel or be located in a terminal box to the back of the same box. In the first case we will have rubber caps to protect the terminals against officers atmospheric.

The terminal box is a good solution if it meets IP535 degree of protection. In installations where panels are fitted in series and the voltage is equal to or greater than 24V install bypass diodes.

The section of the cable must not exceed 6mm. It is also necessary care systems pass the cables through walls and ceilings to prevent entry of water inside. The technique for fixing and laying of cables must be the usual in a conventional installation. The driver may be under the air tube, in the first case can be embedded or not. The clamping flanges shall be by subject, trying not subject to excessive bending radii. The Splices are made with fittings for that purpose, using taps provided as possible.

4.3.10 Electrical outlet company junction

This is part of the installation of a distribution network, which feeds the overall enclosure or its equivalent functional unit (ELECTRICAL COMPANY OUTLET BOX). Cables will be copper or aluminium, with the line regulated by local low voltage standard reference.

Considering its layout, the system installation and grid characteristics, the cables will be insulated, having a rated voltage of 0.6/l KV. It is stressed that the connection be part of the installation of the Company Supplier so that the design and layout is based on the same particular rules.

The processing centre that will connect the facility is subject to a project fully differentiated and which will conform to the highest standards of service offered by the Commercial Electrical Company.

4.3.11 Electronic devices description detail

Figure 27: CDP Control "Zero" Grid Injection

Figure 28: Data Electrical Analyzer. To control the self Consumption

Figure 29: MC current transformer

Figure 30: License Local SCADA Data Logger

4.3.12 Over current protection systems

All circuits shall be protected against the effects of currents can submit the said same to this disruption of this circuit will be performed at a time convenient or be dimensioned for about intensities predictable The above intensities may be caused by:

- Overload due to appliances use or insulation defects of great impedance
- Short-circuits
- Atmospheric electrical discharges

4.3.13 Over voltage protection systems

For overload and short circuit protection, fuses and general (over voltage fuses) is installed with a MCB calibrated.

They also have other disconnectors elements to separate parts of the facility to perform maintenance or repairs.

4.3.14 General Protection Box

The overall enclosure is responsible for safeguarding the entire electrical installation from a short circuit or tip intensity, which would affect all connected components in the network. This general enclosure may be worn as a thermal protection fuse.

4.3.15 Systems of differential protection for people

The general control and protection devices shall be located as close to the point of individual input derivation. He placed a box for switch power control immediately before the other devices in separate sealable compartment.

This box can be placed in the same box where general devices are placed command and protection.

The installer will set permanently on the switchboard plate, printed indelible, which establishes in his name or trademark, date of completion of the installation and the rated current of the circuit breaker switch, protection against indirect contacts of all circuits.

$$Ra \; x \; Ia < U$$

- **R_a** is the sum of the resistances of the grounding and protective conductors mass.
- **I_a** is the current that ensures operation of the protective device (current residual assigned)
- **U** is the conventional limit contact voltage. (50V and 24V in a dry in wet rooms)

4.3.16 Grounding security system

The grounding of the installation is very important as it defines the voltage can I presented at a given mass of metal components currently ensuring performance protection and eliminating the risk posed by the malfunction or breakdown of any of the teams. Grounded outlets are primarily established to limit the voltage that they can present at any given time the metal frames, to ensure the performance of protection and eliminate or reduce the risk posed by a fault in the electrical equipment used.

4.4 Electrical detail scheme

Attached single line scheme connected to the low voltage grid photovoltaic system and not contemplates interface with switchboards of domestic consumption.

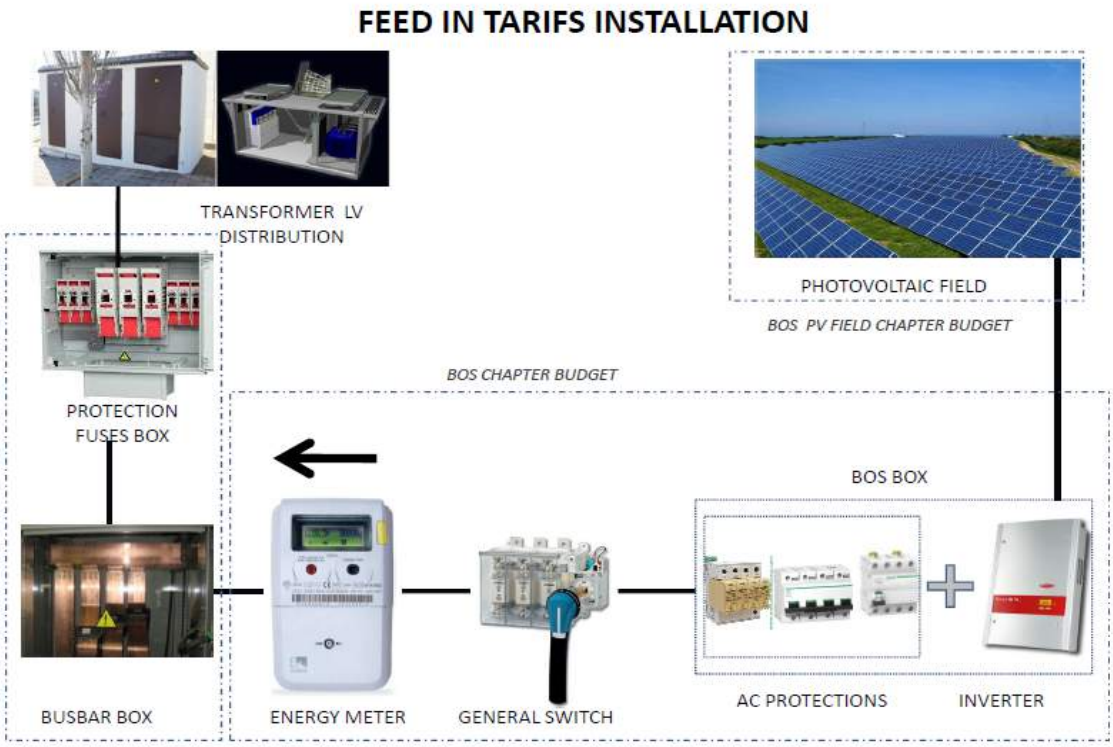


Figure 31 Electrical scheme – Feed in Tariffs

The feed in tariffs installation, the main difference between a self consumption installation is that for the first one, the measure and protection is alone installation with a dedicate electrical export to the external grid, and the self consumption installation use the low voltage building installation with the existing low voltage protections.

It is important the anti islanding protection to push that no electric return when the building is out of the external grid and the system need to incorporate a new protections and controls because the new PV installation can't affect the electrical building system.

This is necessary to adapt the electric scheme to a self consumption installation with the low voltage rules. The modification will be like the next image:

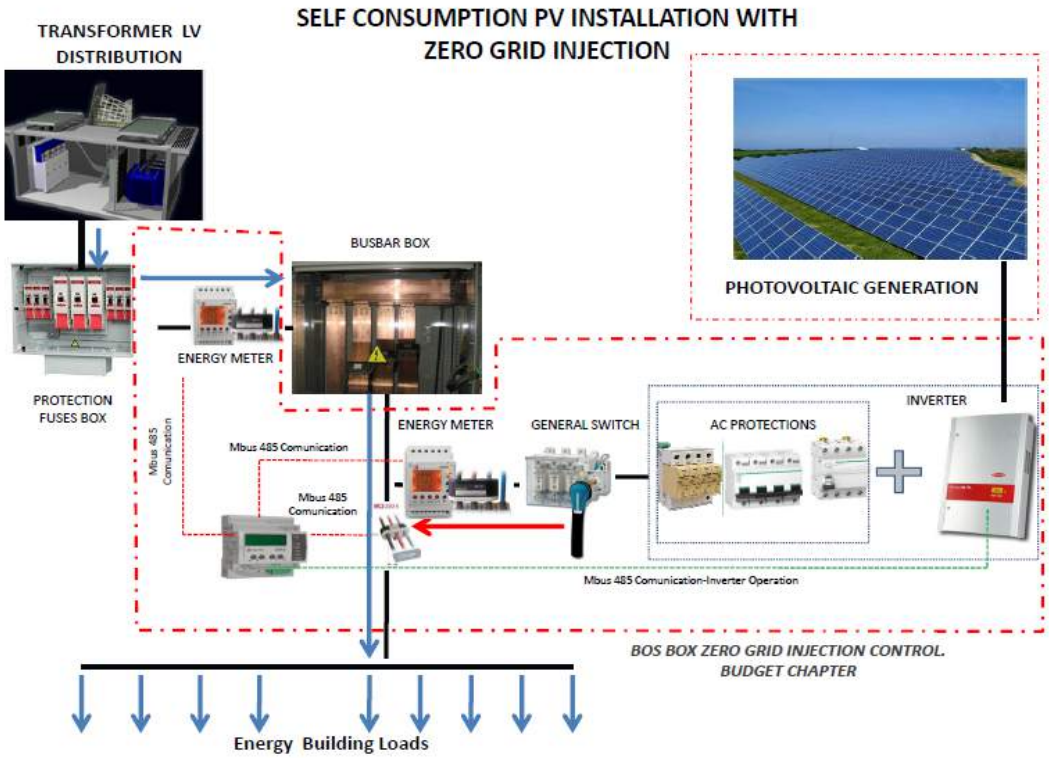


Figure 32 Electrical scheme – Self-Consumption

Low voltage connection scheme

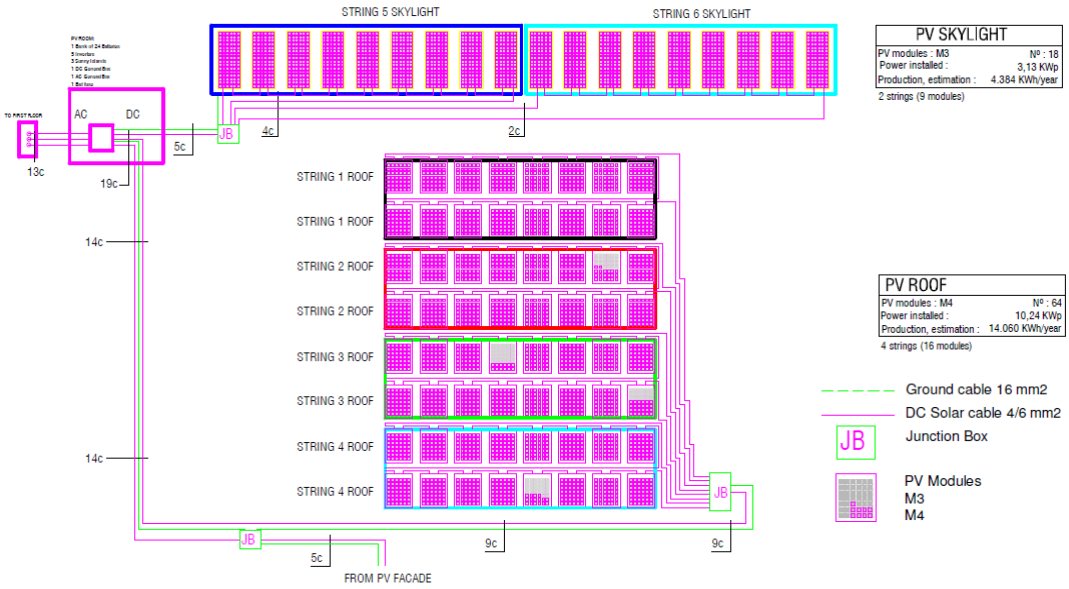


Figure 33 Electrical connection scheme

The electrical scheme has to identify:

- Name of the PV field
- PV power per circuit
- Energy production per circuit
- Name of the string circuit
- Name DC Circuit
- Name of the AC circuit
- Dimension of the AC circuit
- Detail Electrical evacuation circuit and building trace(way)
- Detail of PV room with the devices location and fixation
- Identify the inverter (dimension, model and position)
- Identify the junction Box
- Identify the connectors
- Identify DC solar cable max $6mm^2$
- Identify Ground cable $16mm^2$

- Inverter extension cable dimesion and location in the draw
- Photovoltaic module cable dimension
- Return loop cable dimension and location
- The extension cables dimension and location
- Electrical Calculus per circuit
- The architecture of connections

Attached example of the architecture connections with the name of the loop/circuit, electrical dimension per loop/circuit, inverter model per loop or circuit, reference PV circuit.

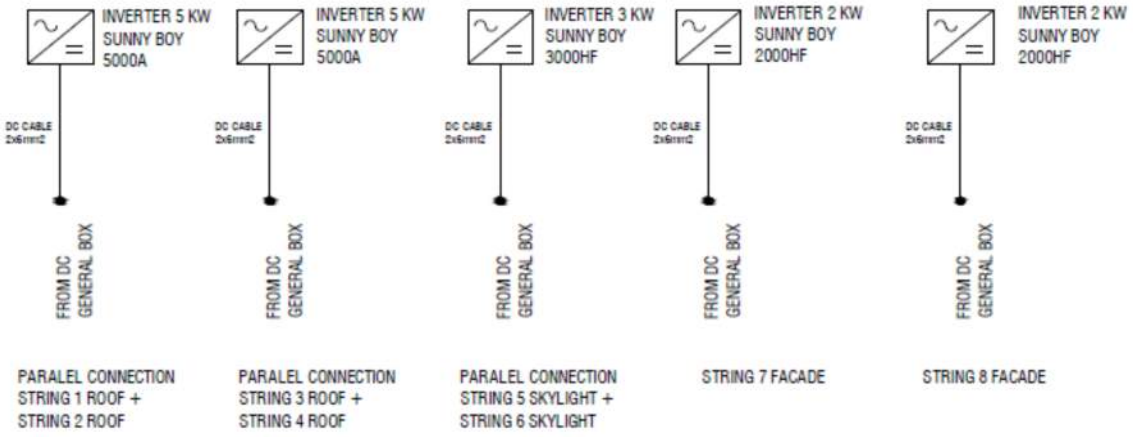

INVERTER 5 KW SUNNY BOY 5000A
INVERTER 5 KW SUNNY BOY 5000A
INVERTER 3 KW SUNNY BOY 3000HF
INVERTER 2 KW SUNNY BOY 2000HF
INVERTER 2 KW SUNNY BOY 2000HF
DC CABLE 2x6mm2
FROM DC GENERAL BOX
PARALEL CONNECTION STRING 1 ROOF + STRING 2 ROOF
PARALEL CONNECTION STRING 3 ROOF + STRING 4 ROOF
PARALEL CONNECTION STRING 5 SKYLIGHT + STRING 6 SKYLIGHT
STRING 7 FACADE
STRING 8 FACADE

Figure 34 Example of the architecture connections

About the PV room, attached example image for the draw or dimension scheme:

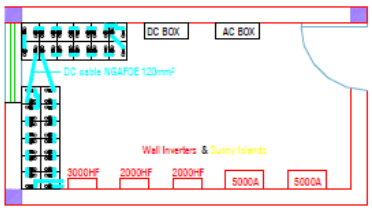


Figure 35 PV room details

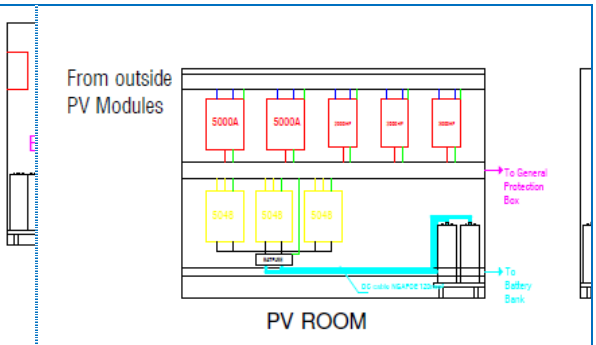


Figure 36 PV room details

The engineer has to represent:

- PV Room building location
- The PV devices location inside the room
- TH PV Box location and dimension
- The inverter location and connections

All the PV room devices, connections, circuits, electrical evacuation circuit has to be represented in a draw with this chapter.

Communication Mbus Connection

The RS 485 Mbus communication, the engineer has to detail the connections and the periferic named devices. It is important to draw the RS 485 communication between the device and the control.

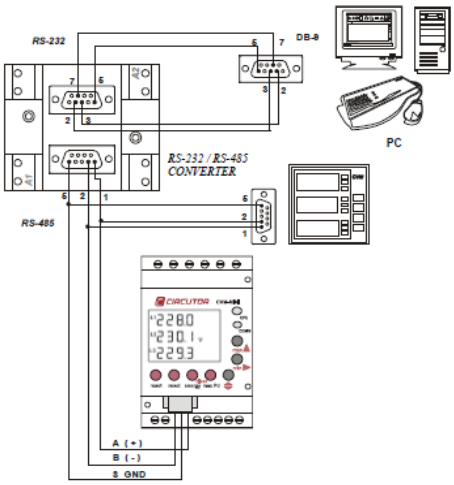


Figure 37 RS 485 Connection scheme

The electrical connection scheme has to represent:

- A(+) Circuit 24 V
- B(-) Circuit 0V
- GND Circuit

The maximum length for the communication is 300 meters. If the distance is more projected the system needs to install a 24 Voltage amplifier.

4.4.1 Monitoring and Zero Grid Injection

The devices to install to control de zero injection to the grid are listed at following:

- CDP
- CVM Mini
- Current Clamps
- EDS (local data Server for SCADA)

At the following some images about the monitoring devices:

The electrical Scheme to connect these devices:

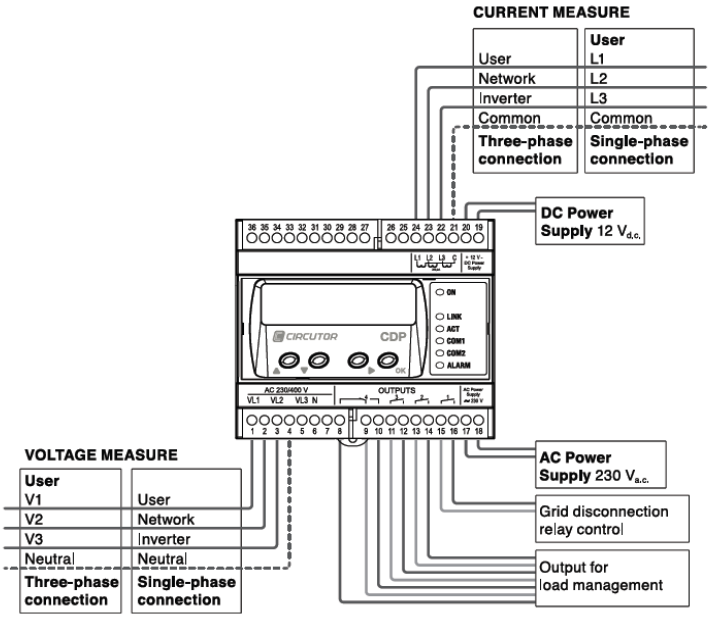


Figure 38: Detail scheme RS 485 communication and electrical connections to the CDP device

The electrical scheme has to detail:

- Low voltage pin device connection
- Voltage AC Pin Power Connection
- Grid disconnection pin relay control
- Pin current Measure connection PV production (Voltage and current)
- Pin current measure connection (self consumption)
- Pin current measure for the grid electrical consumption
- Output signals for the management
- Relays otutput for the inverter

5. SUPPORT SYSTEM DESCRIPTION

The support system solution is part of the architectural design, fulfilling the technical and the aesthetics requirements. All three integrations follow the same principle: substitute one kind of material necessary for construction with another that is not only capable of achieving the same conditions as the original one, but can also produce energy.

The frame is in charge of holding the solar panel. It often will come in a kit, in modules, for proper assembly and installation. In case no kit is provided, the installation must be done in accordance with existing regulations, while taking into account the wind strength among other factors.

The structure must withstand one wind speeds of at least up to 150 km/h. This structure is to be determined by the inclination of the solar panels.

5.1 Considerations to analyze

5.1.1 Snow loads

As a reference for the dimensioning of the systems, we have considered different criteria actions from the Euro Code 1 (Actions in Structures), which contemplates objective values for the countries in the European Mediterranean Basin. These values can be extrapolated, at least, to those African countries with European tradition (Morocco, Algeria, Tunisia and Libya).

To be able to generate an applicable design in any of the above-mentioned zones, the average values from the available references of the coast zones have been considered.

The execution of these actions and the applicability of loads have been implemented following the same regulation. In the case of Turkey, data has been countered with the local regulation, TS498.

When talking about Jordan, data has been measured against with the local regulation of actions in buildings.

The minimum loads to analyze are the following:

- Weight load (0.15 KN/m^2)
- Wind load (0.5 KN/m^2)

5.1.2 Wind loads

Considering that the buildings been analyzed in the studio are public, an urban environment and medium to high height have been assumed. The wind factors considered are the following:

- Roughness of the environment: Urban area
- Height over highest level: 35m

- Wind basic speed: 35m/s

The same as with the snow load, wind speed is different all over the Mediterranean areas.

For example, in the Mediterranean areas of France, the value is approximately 28-30m/s; in Spain, 26-28m/s; in Italy, 25-31m/s; in Greece, 30-36m/s; in Jordan, approximately 35m/s; and more or less 28-36m/s in Turkey and Syria.

In the particular case of Patras or Chania (Greece), the wind speed is of 36m/s.

For Alexandria, Marsa Mathrouh (Egypt) and Al-Salt I Irbid (Jordan), the standard value of 35m/s can be used.

5.1.3 Maintenance overloads

This value is considered in the chases of pergola and skylights, and a value of 1,0KN applied as a located load in the most unfavourable point of the primary structure is considered.

5.1.4 Building's category

Depending on the classification of the building, calculations must be made about climatic zones, involving multiple numeric simulations, so that is possible to assess the impact of the variation of the actions in the support structure for integrated photovoltaic systems.

The numerical discretization obtained has been synthesized into two basic building typologies that will allow the installers to apply the results of the calculations in the evaluation of the structural actions. The risks are shown below:

- B.1 - Buildings 3-5 floors, with 16m maximum height
- B.2 - Buildings 6-9 floors, with 35m maximum height

5.2 Photovoltaic Solutions

The layout of the modules on the cover has to be performed in order to maximize annual energy production. The main parameters that affect the performance of a solar installation are:

- Orientation
- Tilt - Shadows on PV modules
- Electrical losses (due to cable length and section; electrical configuration)
- Ventilation of photovoltaic modules.

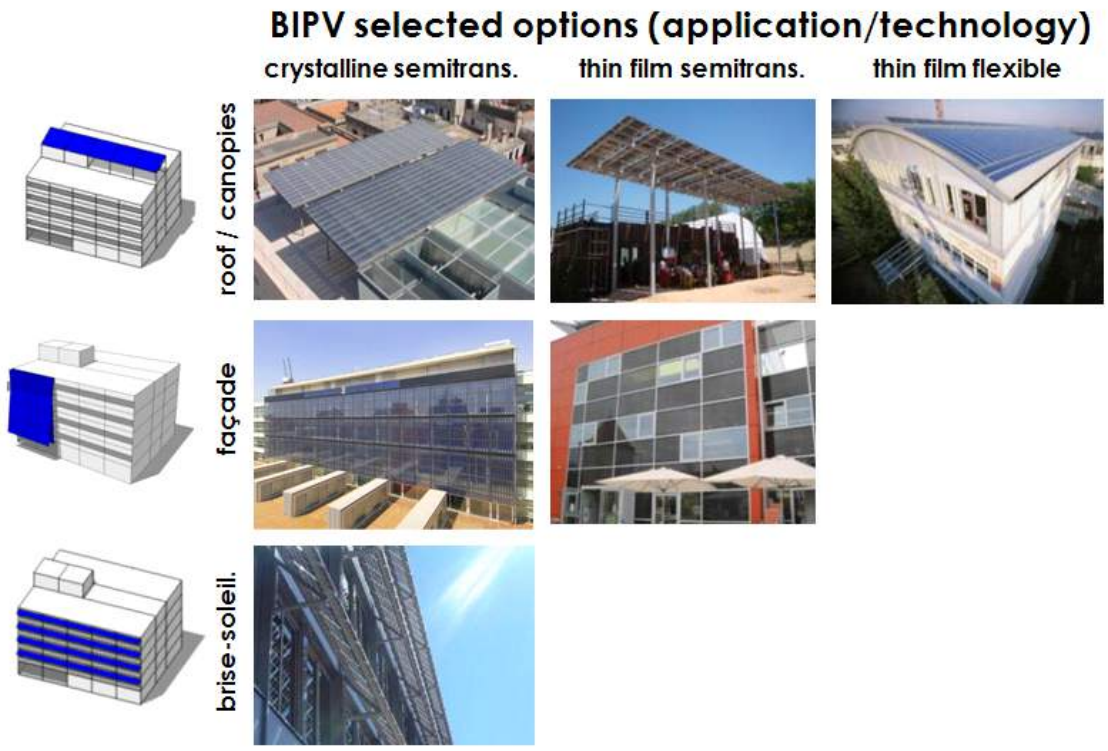


Figure 39 BIPV Selection options

5.2.1 Roof and Skylight

As an external roof or canopy, its main function is to provide a water-tight and sun-protected area. It is an aluminium curtain wall system, which integrates the laminated glass, with the PV cells in between.

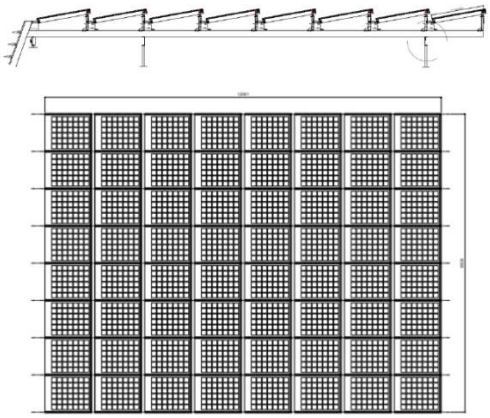


Figure 40 On Roof Solution

The skylight lights the entrance hall and part of the offices, which is why it is absolutely necessary to be water tight but also capable of filtering and controlling the sun rays. 0

For applications of bigger sizes, like atriums or interior yards, it would be necessary to develop a specific studio, as static integration would be an important conditioning value.

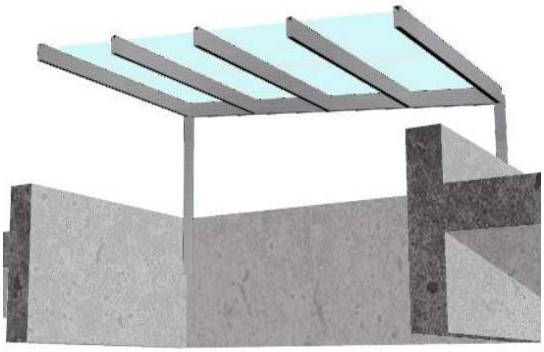
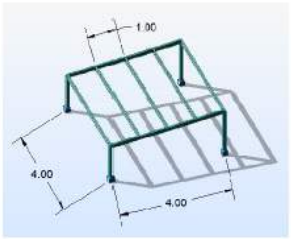


Image Solution



Module type	AM/F/L
Num modules	12
Peak power	1.2kWp
Nominal power of the inverter	1.0kW
Estimated annual production	1.263 kWh/kWp
Base structure	Aluminoum alloy 6063 T6
Leaning module side	Long side
Short sided joint	Elastomeric
Traction support/Anchoring need	Yes

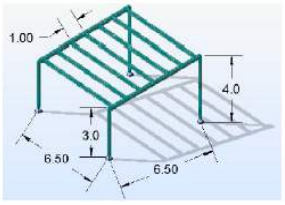
Cost justification

Figure 41 Skylight

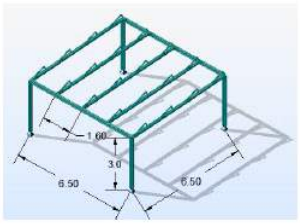
5.2.2 Pergola

A pergola is an architectural and structural element, formed by a runner flanked by vertical columns (called pillars) supporting longitudinal beams (dormant) connecting the columns of each side, and other cross-supported ones above (rafter) for supporting an open latticed roof (I changed stuff). The pergola can stand alone or be attached to a building or other structure in which case the pillars are often removed and secured to the back side of the existing structure.

Their most common use is to protect garden walkways, but they can also be part of a building and give partial shelter to pedestrian areas.



Module type	CR/F/60
Num modules	24
Peak power	6kWp
Nominal power of the inverter	5kW
Estimated annual production	1.208 kWh/kWp
Base structure	Steel S275JR
Traction support/Anchoring need	Yes



Module type	CR/F/60
Num modules	16
Peak power	4kWp
Nominal power of the inverter	3.7kW
Estimated annual production	1.285 kWh/kWp
Base structure	Steel S275JR
Traction support/Anchoring need	Yes

Images Solutions | **Cost justification**

Figure 42 Pergola

5.3 Construction details

5.3.1 Fixation details

Pergola Fixation: With Frame for unsealed Pergola

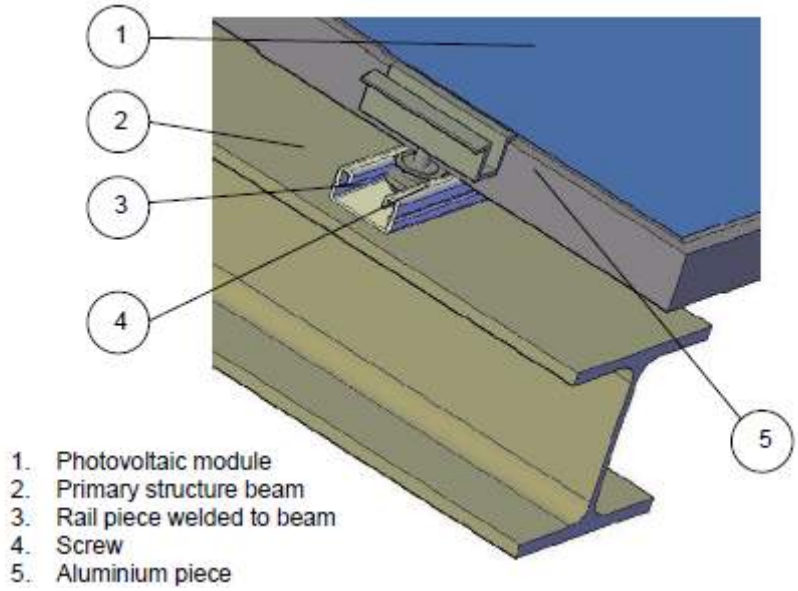


Figure 4543 Fixation Pergola Details

Pergola Fixation: Without Frame for unsealed Pergola

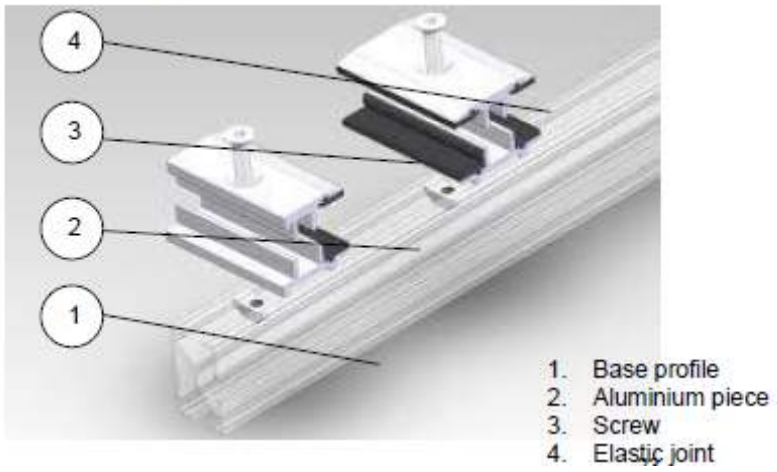


Figure 46 Fixation Pergola Details

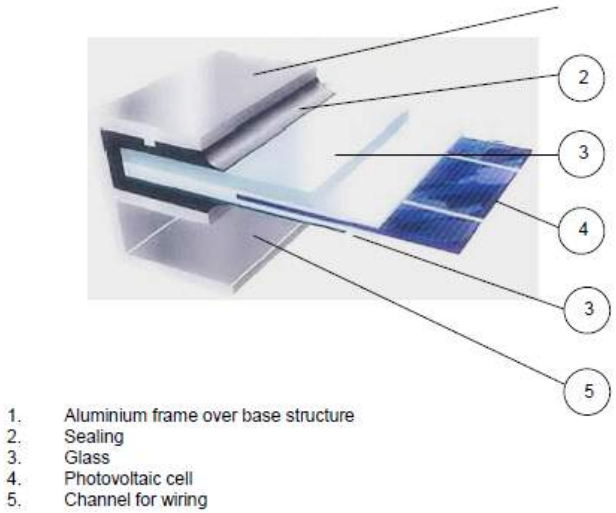


Figure 47 Fixation Pergola Details

5.3.2 Wiring Conduction

The optimum solution in terms of wiring integration is the curtain wall with crystalline modules, where the connection box is fixated to a side.

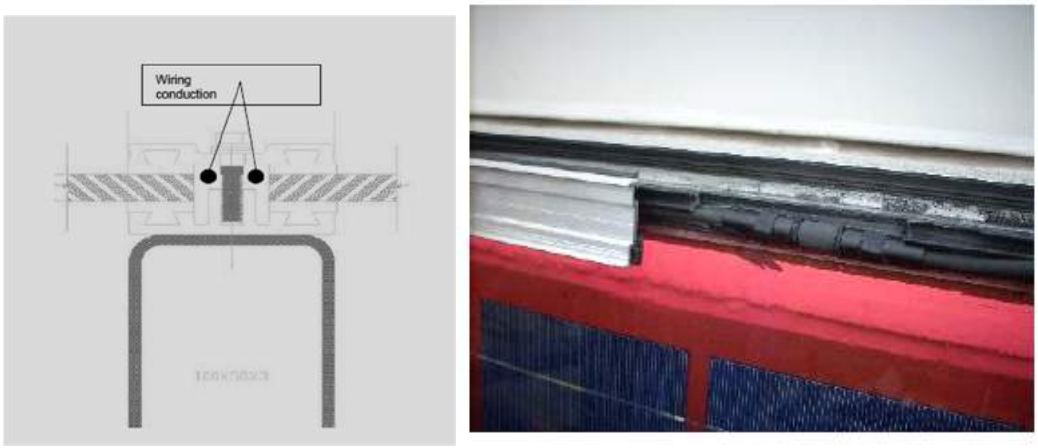


Figure 48 Wiring conduction

The space between the modules and the structure can be over-dimensioned so as to be able to conduct the wiring.

For all other construction applications, it will be necessary to minimize the visual impact of the wiring conduction, either by canalizations overlapped in the loading structure or by using the same structure to conduct the wires.

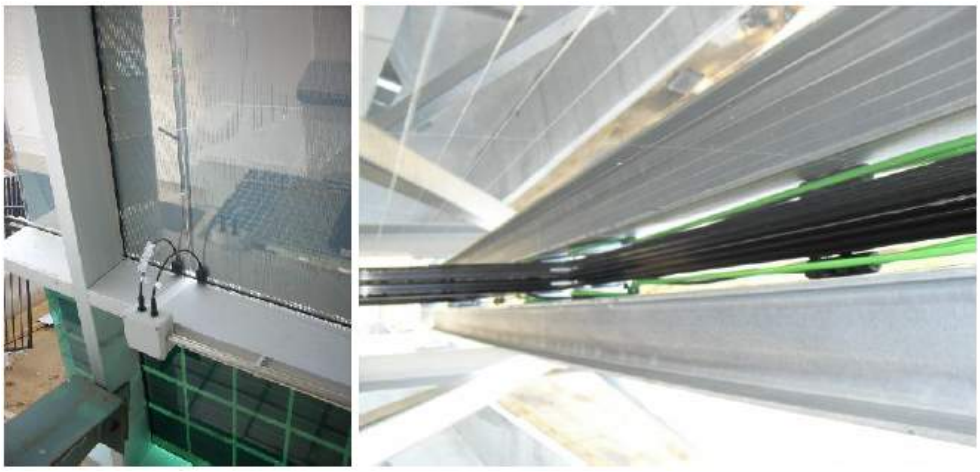


Figure 49 Example wiring conductions minimized

6. SYSTEM MAINTENANCE

Maintaining a photovoltaic installation is scarce. This is practically reduced to cleaning modules, review connections and security features. In some situations it may be necessary to disconnect the network, which would therefore result in small losses.

To ensure high productivity of the plant it is essentially reduced downtimes caused by a system failure or malfunction. For this reason, a good supervision system is needed by the user, offering good Service Assistance.

Standard maintenance operation

Periodic cleaning of the modules should be done once a year. Pay attention to the inverter (Leds, status indicators and alarms) in different sunlight conditions, as this is one of the least reliable parts of the system's equipment. Maintain control of the electrical connections and wiring modules. Carry out visual inspection of the modules to verify glass breakage, moisture penetration inside the module, and connection failures in the event of breakdown.

Other issues of operational maintenance include background checking electrical protection elements for personal safety and the operation of the facility. In general, revise all equipment, wiring, connections and support structures.

The objective of maintenance is to prolong the life of the system, and to ensure good performance and productivity of the plant, especially where installations connected to the grid offer back financial rewards of energy production.

Planning standard maintenance operation

I. USE AND SPECIFICATIONS

- Should be kept within acceptable limits operating conditions, performance, protection and durability of the installation.
- Should be replaced with items worn by use, to ensure the system works properly during their lifetime.
- Should be observed main operating parameters (voltage and power) to verify the correct operation of the installation.

II. MAINTENANCE BY QUALIFIED PROFESSIONAL

- Every six months:
- Checking electrical protection
- Checking the status of modules, checking the situation with respect to the original project and verifying the status of connections
- Checking the status of the inverter, its operation, lights and alarm signaling
- Checking the status of mechanical cables, terminals, plates, transformers, fans, pumps, unions and cleaning.

7. ENERGY STUDY

To estimate power generation as realistically as possible in the simulation, it is necessary to schedule and use sunlight to integrate all system losses. For this, we use the software version PVSyst, developed by the University of Geneva. This one of the most recognized software in the field and takes into account the method of calculation described above (see calculation details in annexes).

For the study, we carried out a simulation using PVSyst, which took into account size and data analysis for the complete PV system, and was reproduced in similar conditions as the projects.

To carry out an estimation of energy production, it is necessary - apart from the characteristics of photovoltaic glazing - to take into consideration the following information:

- Orientation: corresponding to the orientation of the photovoltaic surface respect to the South.
- Inclination: angle that corresponds to the surface of the module and photovoltaic glass and the horizontal plane.
- Shadows: shadow effects felt by the orientation of the facade, where the value is represented in %.
- Installed power: real power is installed, calculated from the maximum output of peak power of the sum of all the solar panels that compose it.
- System loses: includes all the components, with special attention to the cable voltage drop.

The concepts defined in the energy estimation are these:

- PV power modules: the sum total of individual power module sizing in the proposal.
- Power Inverter: the inverter rated power necessary to optimize the performance of the installation. This power rating is usually between 8 and 14% less than the PV power modules.
- Annual energy produced: the result of expected annual energy obtained from the installation location conditions, slope, orientation, power capacity and system efficiency estimates.
- Ratio kWh / kWp: represents the total number of hours of plant operation under rated power in a year.
- Ratio kWh/m^2 or kWh / ml: represents the energy production per square meter of front panel in the case of integrated, or energy production per meter in the case of Brie Soleil.
- Performance ratio (PR): defined as the relationship enters the energy that a PV system actually sold to the grid, and would sell a hypothetical PV system ideal, defined as one whose solar cells always work at reference temperature (25 ° C) and that otherwise is free of losses.
- Annex report PVSYST program

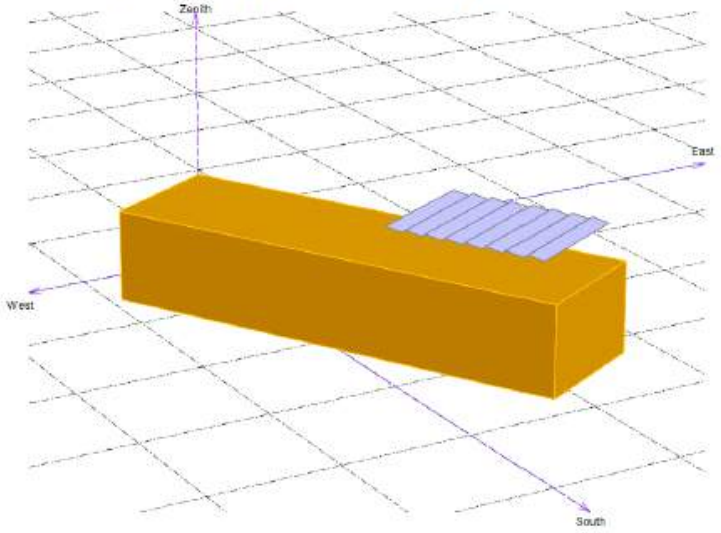
The results obtained are shown in the following chapter:

Latitude	13º N
Orientation	-28ª
Inclination	10ª
Power installed (kWp)	10

Total power installed (kW)	10
Inverter power (kW)	5
Annual energy produced	14.060
Ratio kWh/kWp	1.373
Ratio kWh/m²/ml	140,4
Performance ratio (PR) (%)	70,3
Total losses (%)*	4,1

*Total losses represent the losses accumulated by the factors of inclination, orientation, shading between modules.

Perspective of the PV-field and surrounding shading scene



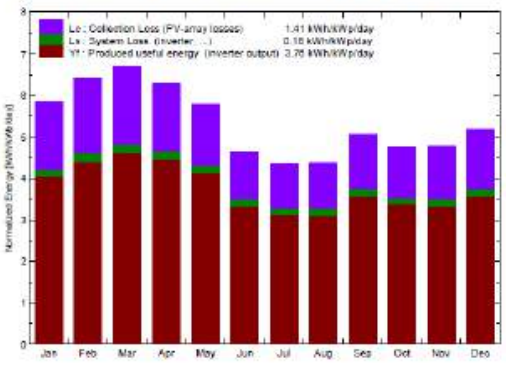
Main simulation results

System Production

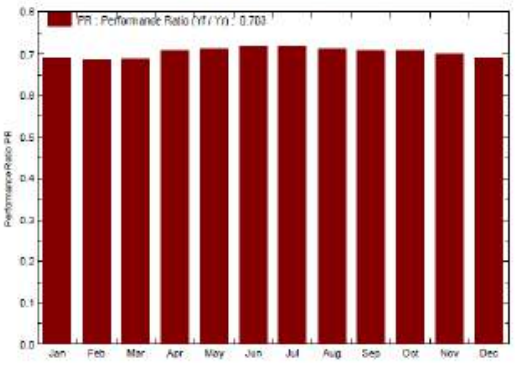
Produced Energy **14.06 MWh/year** Specific prod. 1373 kWh/kWp/year

Performance Ratio PR 70.3 %

Normalized productions (per installed kWp): Nominal power 10 kWp


Lc : Collection Loss (PV-array losses) 1.41 kWh/kWp/day
Ls : System Loss (inverter ...) 0.18 kWh/kWp/day
Yf : Produced useful energy (inverter output) 3.78 kWh/kWp/day
Normalized Energy [kWh/kWp/day]
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Performance Ratio PR



8. ENVIRONMENTAL BALANCE

Not all energy sources pollute the same or cause the same emissions. For example, coal is more polluting than diesel, which in turn produces more emissions than natural gas.

Photovoltaic energy helps reduce emissions of pollutants into the environment of the main greenhouse gases are CO_2, SO_2, and NO_X.

To calculate the savings in emissions, we used the value of emissions involved generating one.

The benchmarks are shown:

GAS	ELECTRICITY	
CO2	0.503	Kg/kWh
SO2	0.00023	Kg/kWh
NOx	0.00047	Kg/kWh

With total production of the proposed facility is a saving of

ANNUAL PRODUCTION ESTIMATED (kWh/year):	**135438**
EMISSIONS SAVINGS	
CO2(Kg.)	**68.938**
SO2(Kg.)	**31.150**
NOx(Kg.)	**63.655**

9. BIBLIOGRAPHY

[1] A.T.KEARNEY and ESTELA. “Solar Thermal Electricity 2025”. June 2010.

[2] Greenpeace International, SolarPACES and ESTELA. “Solar Power Global Outlook 09”, 2009.

[3] http://www.ripassoenergy.com/images/pressrelease/Ripasso_Energy_Release_15Jan_2013.pdf (Ripasso Energy) checked in July 2013

[4] Kalagirou, S. A. “Solar Energy Engineering” Processes and Systems. Chapter ten – Solar Thermal Power Systems. Elsevier, 2009.

[5] http://www.window.state.tx.us/specialrpt/energy/renewable/solar.php (Window on State Government) checked by July 2013.

[6] http://www.unitedsunsystems.com/ (United Sun Systems) checked in July 2013

[7] http://electricidad-viatger.blogspot.com.es/2008/07/interruptores-automticos-magnetotrmicos.html checked in December 2013

[8] Ministerio de Ciencia y Tecnología "Reglamento Electrotécnico de Baja Tensión" Setiembre 2002

[9] http://www.engineeringtoolbox.com/propylene-glycol-d_363.html The Engineering Toolbox checked in December 2013.

[10] http://www.circutor.es. Documents Photovoltaic solutions sellf consumtion

[11] http://www.Fronius.com. Self Consumption-Iverter solutions

[12] http://www.SMA.com Photovoltaic products & self consumption solutions

[13] http://www.IDAE.es Guía del autoconsumo Fotovoltaico

[14] http://www.albasolar.es

[15] CIRCUTOR. cat_autoconsumo_GB.pdf

[16] CIRCUTOR. CDP self consumption

[17] CIRCUTOR. Guía técnica para el autoconsumo

[18] CIRCUTOR. Certificado de garantía para la inyección cero.

[19] ALbaSolar. E-Catalogo_Albasolar_2014.pdf

[20] CIRCUTOR. revista_2012_02_gb.pdf. Revista de soluciones energéticas eficientes y autoconsumo.

[21] CIRCUTOR. Software para la gestión energética y autoconsumo.

[22] www.solratys.org Clúster de la Energía Solar española

[23] www.suelosolar.com Asociación industria solar española. Estado de la normativa legislación en autoconsumo.

[24] PLF. Plataforma legal productores fotovoltaicos.

ANNEX I

PV SYST SIMULATION

Energy production will be simulated by using internationally approved software (such as PVSyst), taking into account all the system technical inputs and the environmental parameters, including the nearby shadows.
All the potential of PV energy production is expected to be consumed either by the building or the grid.

PVSYST V5.55 | 22/12/13 | Page 2/3

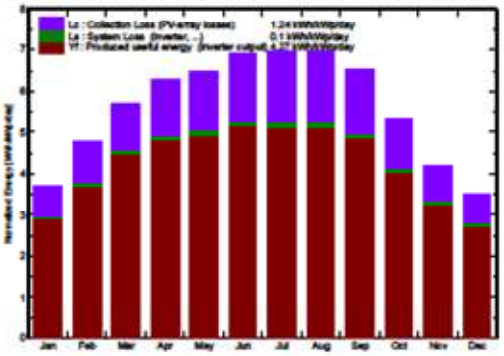
Grid-Connected System: Main results

Project : Matrouh_VS36C54P202

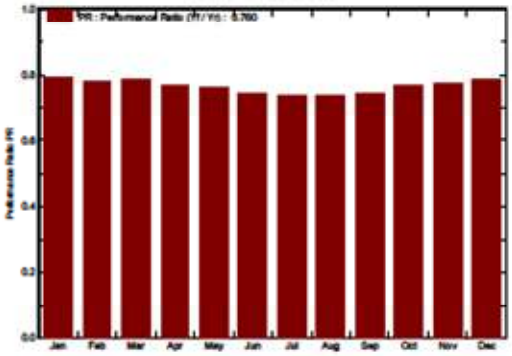
Main system parameters	System type	**Grid-Connected**			
PV Field Orientation	tilt	30°	azimuth	0°	
PV modules	Model	VS 36 C54 P202	Pnom	202 Wp	
PV Array	Nb. of modules	51	Pnom total	**10.30 kWp**	
Inverter	Model	Sunny Mini Central 10000 TLPnom		10.00 kW ac	
User's needs	Unlimited load (grid)				

Main simulation results
System Production — **Produced Energy** **16041 kWh/year** Specific prod. 1557 kWh/kWp/year
Performance Ratio PR 76.0 %

Normalized productions (per installed kWp): Nominal power 10.30 kWp



Performance Ratio PR



Balances and main results

	GlobHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	EffArrR %	EffSysR %
January	84.9	15.30	114.1	110.9	953	929	7.46	7.28
February	102.5	15.00	133.6	130.0	1100	1073	7.36	7.18
March	154.4	16.20	176.9	172.1	1461	1428	7.38	7.21
April	187.2	18.80	188.7	182.9	1525	1489	7.22	7.05
May	218.6	21.60	201.4	194.9	1612	1575	7.16	6.99
June	236.7	24.70	207.1	200.2	1627	1589	7.02	6.86
July	242.4	26.50	215.9	208.7	1678	1639	6.95	6.79
August	221.9	27.10	216.2	209.7	1679	1640	6.94	6.78
September	178.2	25.90	195.6	190.0	1534	1500	7.01	6.85
October	134.8	23.10	164.2	159.7	1324	1293	7.20	7.04
November	93.6	19.90	126.2	122.7	1032	1008	7.31	7.14
December	77.5	16.70	108.5	105.3	900	878	7.42	7.23
Year	1932.8	20.93	2048.5	1987.1	16425	16041	7.17	7.00

Legends: GlobHor Horizontal global irradiation; T Amb Ambient Temperature; GlobInc Global incident in coll. plane; GlobEff Effective Global, corr. for IAM and shadings; EArray Effective energy at the output of the array; E_Grid Energy injected into grid; EffArrR Effic. Eout array / rough area; EffSysR Effic. Eout system / rough area

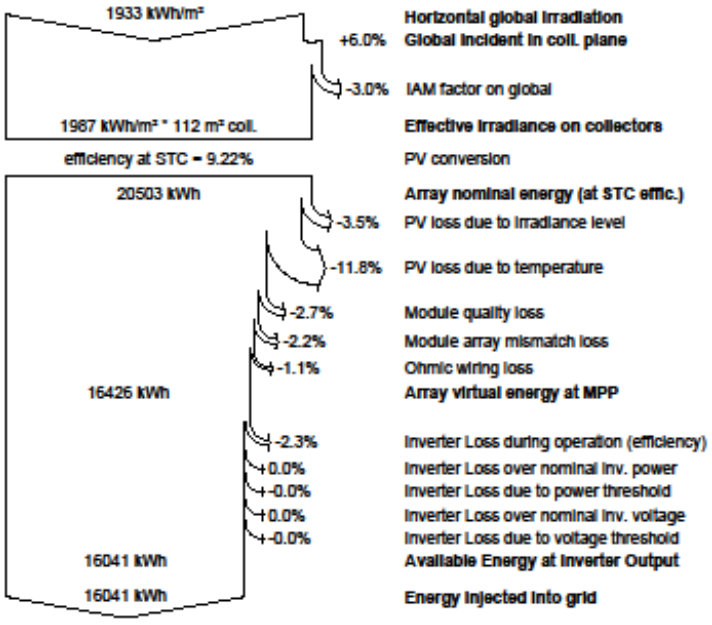
PVSYST V5.55		22/12/13	Page 3/3

Grid-Connected System: Loss diagram

Project : **Matrouh_VS36C54P202**

Main system parameters	System type	**Grid-Connected**			
PV Field Orientation	tilt	30°	azimuth	0°	
PV modules	Model	VS 36 C54 P202	Pnom	202 Wp	
PV Array	Nb. of modules	51	Pnom total	**10.30 kWp**	
Inverter	Model	Sunny Mini Central 10000 TL	Pnom	10.00 kW ac	
User's needs	Unlimited load (grid)				

Loss diagram over the whole year



ANNEX II

WORKING PLAN

WORKING PLAN

Description of the tasks	Staff	Days	Month 1				Month 2				Month 3			
			Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
0 **Administrative Process**		**4**												
1 **Preparation of structure and welding**	2	4												
2 **Mechanical assembly - Skylight**		**108**												
2.1 Pre-assembly structure	4	9												
2.2 Installation of PV modules	4	10												
2.3 Encapsulated of structure	4	4												
2.4 Sealing	2	4												
2.5 Assembly - wiring cover	2	2												
2.6 Review of paint	2	2												
3 **Mechanical assembly - Roof**		**15**												
3.1 Installation of studs	3	1												
3.2 Laying the first row	3	1												
3.3 Laying the second row	3	3												
4 **Mounting electrical installation**		**50**												
4.1 Connection of PV modules	2	4												
4.2 Wiring installation	2	8												
4.3 Inverters installation	2	5												
4.4 General Protection Box installation	2	5												
4.5 Connection to supply connection	2	3												
5 **Commissioning and Legalization**		**22**												
5.1 Checking	3	5												
5.2 Commissioning	2	3												
5.3 As-Built Project	-	-												
5.4 Legalization	1	1												

ANNEX III

MONITORING SYSTEM

The Monitoring system for PV installation should read the parameters; PV production of three different fields: Façade, Roof and Skylight; CO_2 avoided; energy consumption of electrical load connected; power quality supplied to the load; grid power quality; export import capacity; and, the total energy consumption on the building.

The parameters can be shown via internet and it is required the data can be displayed to the public by a screen, too. It should include all necessary materials for installation (RS485 wire, software, computer, protections, etc.).

Two computers are needed for the connection, one for the local connection and the other for the SCADA central data base.

Both computers have to be connected to the same grid, and have connection to the internet. The entire system works with web pages, so the information can be retrieved from any computer having an Internet or intranet connection.

The different situations we have to handle are the following:

1. **Internal connection**

   Internal connection of the "second screen" and clients on the LAN to handle this, we have to configure a static IP address for the monitoring system, and use it on the clients, or use DHCP and be sure that the machine name will be correctly updated on the DNS, so we can use the name for accessing.

2. **External access**

   Once again, we have two choices: Fixating a static IP address and opening an incoming port (80 if possible), and having a fixed IP address or a DynDNS name for the WAN connection, or, we can use the remote view system of Circutor, to put the system online, for this purpose, we'll need the outgoing connections to port 22 to be granted on or firewall, if any.

   Be careful about the second option: Circutor server is located in Germany, so the data would have to go from India to Germany and back again, slowing down the system. A third option would be having an external server closer.

3. **Remote access**

   The monitoring needs remote access to both computers in order to configure them, do the tests and for maintenance. For that the system use VNC, and once again we can redirect some ports to the VNC of the computers, or use the remote view system. A static IP address can connect to global data center with a route for each photovoltaic installation.

A detailed layout of each site with suitable scale spacing between all monitoring and control equipment shall be given by the tendrer. At the end of the project, the Contractor shall supply two CD's loaded with all PLC programs of all equipment of the 4 buildings.

1. FEATURES OF MONITORING SYSTEM

Remote parameterization of equipment

This allows parameterization of all on-line connected equipment, thus facilitating all settings from the PC or server control. It allows for viewing the parameters in real time; the real-time display of all equipment; knowing at all times the performance of the facility; and, the state of electrical distribution lines and thermal installation.

Multi Software (Embedded Web Server)

Through the internal web server, any user connected to the corporate network of the company (LAN) or from any connected Internet point (if set in the router, Check the company, factory, etc.. The ratio of public IP to private IP)

You can view historical data or real time data, which is updated constantly.

Integrated XML Server

This has specialized tools of trade, dynamic data, in order to integrate energy monitoring system overall control; containing servers communication for XML integration (delocalized integration).

In a charge distribution (or remote installations), the system allows control of individual consumption each of the facilities and centralize in a single EXTRUDED core application, in order to perform full control of consumption and / or comparison similar facilities.

- Control the consumption of their remote locations efficient, easy and simple
- Reports energy areas or sites consumption
- Remote alarms about consumption and incidents in the mains of different areas of consumption
- Possibility to compare the consumption of different sites.

Energy management system: Accumulation system

Photovoltaic systems interconnected to the network are not the best choice for household consumers whose consumption depends on hours with little or no sunlight. This solar system is intelligent, it knows when and when not to inject energy to the building but the accumulation in this case is not contemplated in the project DIDSOLIT-PB.

Energy management system: Instantaneous Self Consumption with zero injection

This is ideal for those buildings with electricity consumption in daylight hours. The equipment, the CDP family (Dynamic Power Control), adjusts the power output of photovoltaic inverters to what is being consumed at all times. In this way, we ensure a zero injection network.

Features: Zero injection to the network without energy dissipation or electromechanical switching of dynamic power control of solar Photovoltaic modules investors by shifting the working point of the modules.

- Monitoring of energy flows systems
- Data recording system operation
- Available for both single phase and three phase
- Controllability of different inverters
- Control relay off redundant network
- Control up to three circuits in version CDP- G (with demand management).

Data logging and monitoring

- Data logging and essential hardware and software supported with Bluetooth and internet connection.
- Ability to be connected with temperature and solar irradiation sensors.

Solar Radiation and Temperature Sensor

Solar Irradiance Sensor

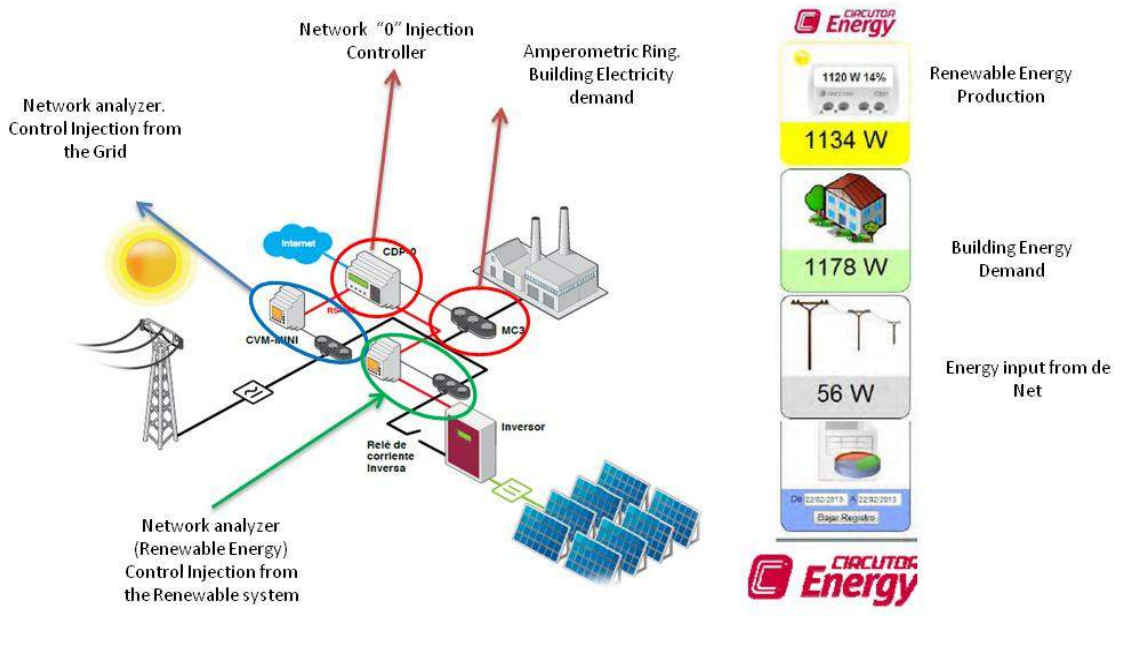
- Measuring range 0- 1500W/ m2
- Sensor: is thermo element or photo cell
- Solar spectrum : 250 – 2800 nm
- Non linearity: < 0.2% at 0 -1000W/m2

Ambient and PV module temperature sensors

- Measuring range -20 to+90 °C
- Accuracy: <0.1°C through the whole range
- Resolution: at least 0.1 °C

Display Screen

- Five Indoor and five outdoor display screens and four digital IP cameras.
- Display screen shall indicate the key system measurements such as; Solar irradiation, ambient and module temperature, produced electricity, saved CO2 Emissions, etc..



CDP Data logger SCADA vision an conceptual connection devices

2. DEVICES FOR THE ZERO INJECTION

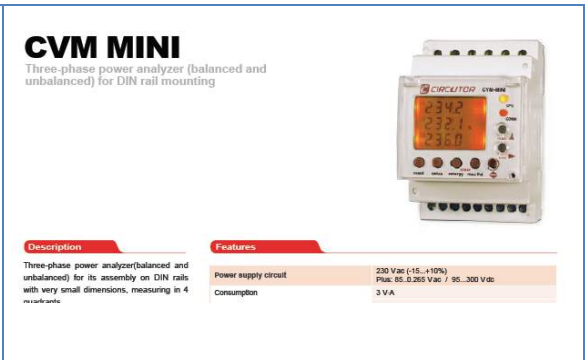
The devices to install to control de zero injection to the grid are listed at following:

- CDP (Dynamic Active Control Power & SCADA data logger solution)
- CVM Mini (Net analyzer)
- Current Clamps

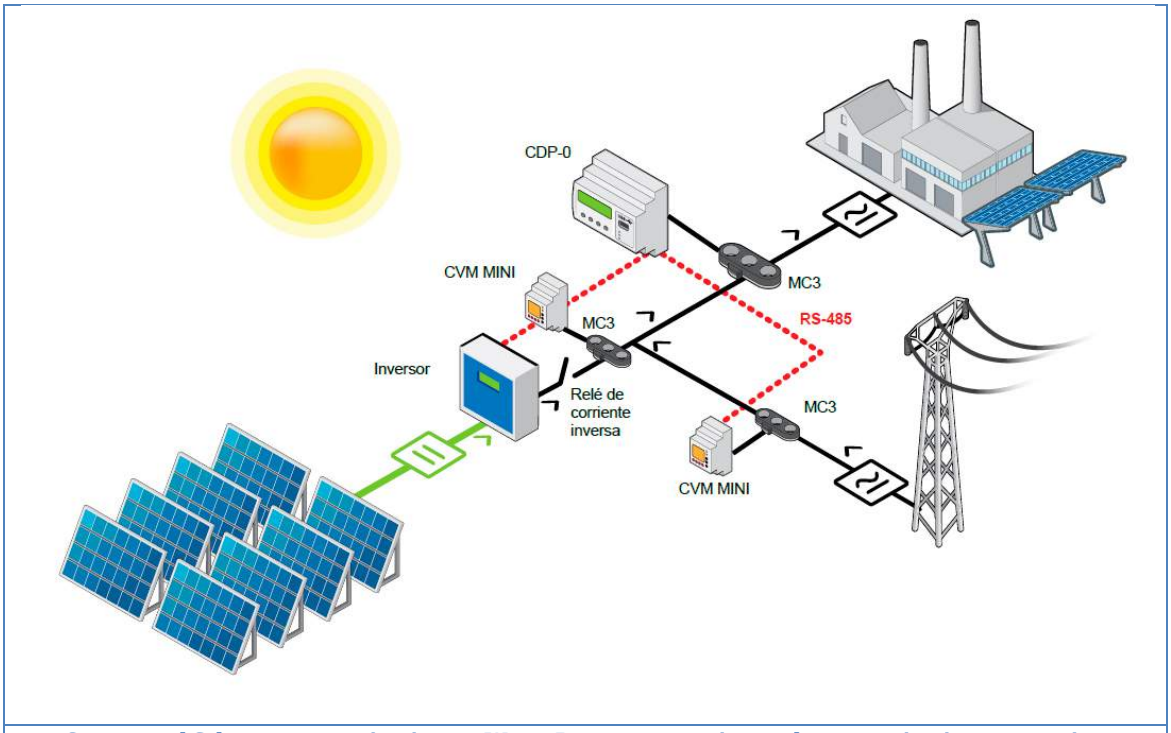
The following are some images about the monitoring devices:

CDP
Dynamic Power Control
Description
A family of power control devices by shifting solar module power point to match user's consumption at any moment.
One of the main features of this device is the ability to measure all power flows of the PV System:
User consumption
Inverter output
Balance with the grid
Auxiliary generation

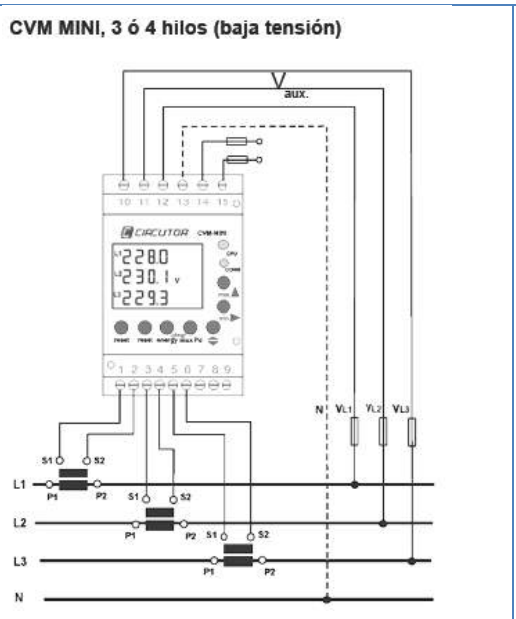
CDP Control



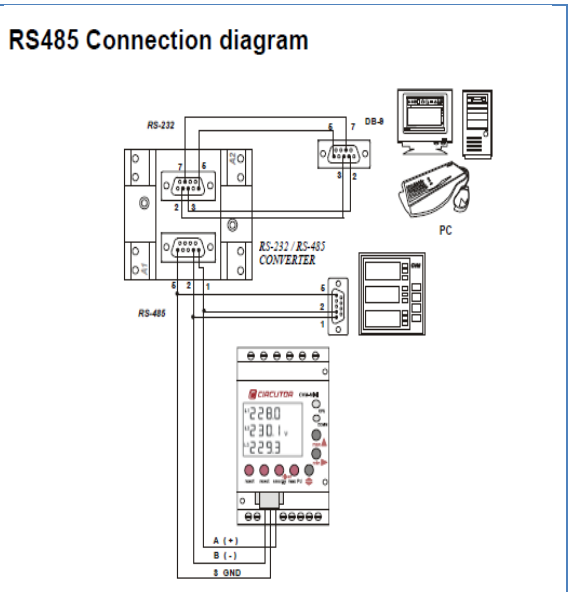
Net Analyzer Control



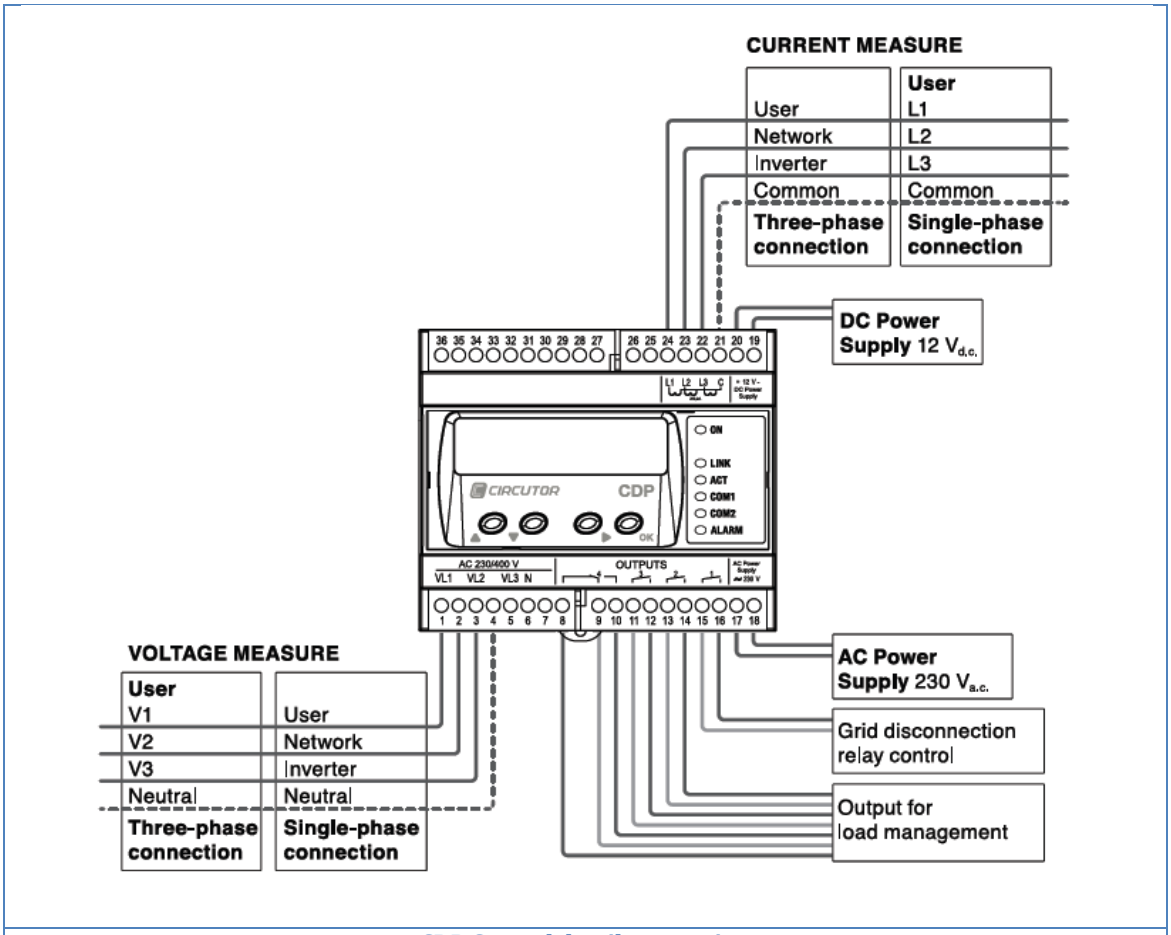
Conceptual Scheme connection in two Ways. Power connection and communication connection



CVM Net Analyzer Power connection



RS 485 connection



CDP Control detail connection

ANNEX IV

SUPPORTING CALCULATIONS

1 ELECTRICAL CALCULATIONS

1.1. Voltage drop

Levels of electrical installation sections of conductors were calculated for currents and voltage drops are within voltage drop of no more **than 3%.** After making an initial estimate of the section we will calculate the resulting voltage drop.

We will use the following expressions:

Three fases voltage

$$I = \frac{PC}{\sqrt{3}\ x\ U\ x\ \cos\rho\ \mathbf{x}\ R}\ (A)$$

$$e = \frac{L \cdot Pc}{K \cdot U \cdot n \cdot S \cdot R} + \frac{L \cdot Pc \cdot Xu \cdot \sin\varphi}{1000 \cdot U \cdot N \cdot r \cdot \cos\varphi}[V]$$

Single fase voltage:

$$I = \frac{Pc}{U \cdot \cos\varphi \cdot R}[A]$$

$$e = \frac{2 \cdot L \cdot Pc}{K \cdot U \cdot n \cdot S \cdot R} + \frac{2 \cdot L \cdot Pc \cdot Xu \cdot \sin\varphi}{1000 \cdot U \cdot N \cdot r \cdot \cos\varphi}[V]$$

Where:

Pc = Power Calculation in Watts

L = length in meters calculation

e = voltage drop in Volts

K = conductivity. Copper 56. Aluminum 35

I = Current in Amps

U = voltage in volts (three phase or single phase)

S = conductor cross section in mm^2

Cos θ = cosine of the power factor

R = Performance

N = Number of conductors per phase

Xu = reactance per unit length

We will use the following expressions:

Current:

$$I = \frac{P}{U \cdot \cos\theta}$$

Drop voltage:

$$\Delta U = \frac{2 \cdot L \cdot I \cdot \cos\theta}{\lambda \cdot S}$$

Where:

P: Active power [W]

U: voltage [V]

I: current [A]

Cos θ: Power factor (value 1)

A U: Voltage Drop I: Length of Line

S: Conductor [mm2]

λ: conductivity of the conductor (copper in this case = 56)

1.2. Wiring sizing

Same as previous chapter.

2. ENVIRONMENTAL IMPACT

Not all energy sources pollute the same or cause the same emissions. For example, coal is more polluting than diesel, which in turn produces more emissions than natural gas.

Photovoltaic energy helps reduce emissions of pollutants into the environment of the main greenhouse gases are CO_2, SO_2 and NO_X.

As explained in Sec. 7&.8 of Annex 1, the Bidder has to fulfil the below table of environmental benefits for each PV system of the four selected buildings .

Table 1. Environmental benefits of PV system

RE system - Environmental benefits	
Annual energy savings, electrical [kWhe]	X,XXX.XX kWh
Life time energy savings, electrical [kWhe] 25 years (1% annual performance decrease)	X,XXX.XX kWh
CO_2 emission savings [kg CO_2/kWh] - Life time	X,XXX,XX kg CO_2/kWh
SO_2 emission savings [kg SO_2/kWh] – Life tim e	X,XXX,XX SO_2/kWh
NO_x emission savings [kg NO_x/kWh] – Life time	X,XXX,XX kg NO_x/kWh

PART 2

DRAWINGS AND SCHEMS

FOUR SITES DESCRIPTION

DIDSOLIT- PB project includes the installation of 79.2 Kw of solar PV in 4 public buildings in Matrouh city located 450 km north west of Cairo. these 4 buildings are:

1. Matrouh Governorate building
2. M.E.I.L.S. Language school
3. General hospital of Matrouh
4. Public library of Matrouh

The description of the sites and locations , details and specifications giving in the following parts, represent the general requirements that should be satisfied by the Bidder for each site.

Below you can find a non-scaled map that identifies the site, the location and the layout of the 4 buildings.

Building data

Building 1 : Matrouh Governorate

- Location: El Cornish Street, Matrouh
- Ownership: Governorate of Matrouh
- Use: Offices
- Building surface: 3.200 m^2 (approx.)
- Electricity consumption: 525.000 kWh (approx.)

Building 2: M.E.I.L.S School

- Location: El Cornish Street, Matrouh
- Ownership: Governorate of Matrouh
- Use: Offices, labs
- Building surface: 1.240 m^2 (approx.)
- Electricity consumption: 23.623 kWh (approx.)

Building 3: General Hospital

- Location: Alexandria Street , Matrouh
- Ownership: Governorate of Matrouh
- Use: Health care centre
- Building surface: 11.520 m^2 (approx.)
- Electricity consumption: 978.276 kWh (approx.)

Building 4: Public Library

- Location: El Cornish Street, Matrouh
- Ownership: Governorate of Matrouh
- Use: Culture center
- Building surface: 1.300 m^2 (approx.)
- Electricity consumption: The library will be inaugurated on Sep.2014

SOLAR ENERGY SYSTEM :

Building 1: Governorate

- System application: BIPV integration, Pergola
- PV module technology: semi-transparent glass-laminated crystalline modules
- Installed power: 44.2 kWp
- Electricity production: 40.193 kWh/year (approx.)??
- Estimated surface: 303?? m^2

Building 2: School

- System application: BIPV integration, Pergola
- PV module technology: semi-transparent glass-laminated crystalline modules
- Installed power: 5 kWp
- Electricity production: 8.393 kWh/year (approx.)
- Estimated surface: 64.86 m^2

Building 3: Hospital

- System application: BIPV integration, Pergola
- PV module technology: semi-transparent glass- laminated a-Si thin film modules
- Installed power: 20 kWp
- Electricity production: 49.760 kWh/year (approx.)
- Estimated surface: 516??? m^2

Building 4: Library

- System application: BIPV integration, Pergola
- PV module technology: ETFE laminated flexible thin film (a-Si) modules
- Installed power: 10 kWp
- Electricity production: 33.173 kWh/year (approx.)
- Estimated surface: 445.8?? m^2

Objectives & Opportunities

Building 1: Governorate

•PV cooling in 16 offices of the third floor where no A\C units exists. Implementing PV cooling will be the first Solar application in the region.

• The building has an excellent visibility in the city. Local SMEs active in the field of RES will get experience from the operation of these innovative solar technologies and will be able to support them in the future.

Building 2: School

• The operation of the system will give the opportunity to students to increase their awareness of the importance of solar energy.

• The installation and operation of the systems will give the opportunity to post graduate students to do research and write dissertations about these technologies.

• Various local schools and stakeholders will be informed through seminars and newsletters about these innovative solar technologies and their possible future uses

Building 3: Hospital

• Installed PV system generates electricity and cooling.

• The roof surface and orientation are suitable and a primary substructure as pergolas, is required where MORTHAN 200 PV units of thin film modules will be installed over 12 pergolas having 2.8 meter height each.

Building 4: Library

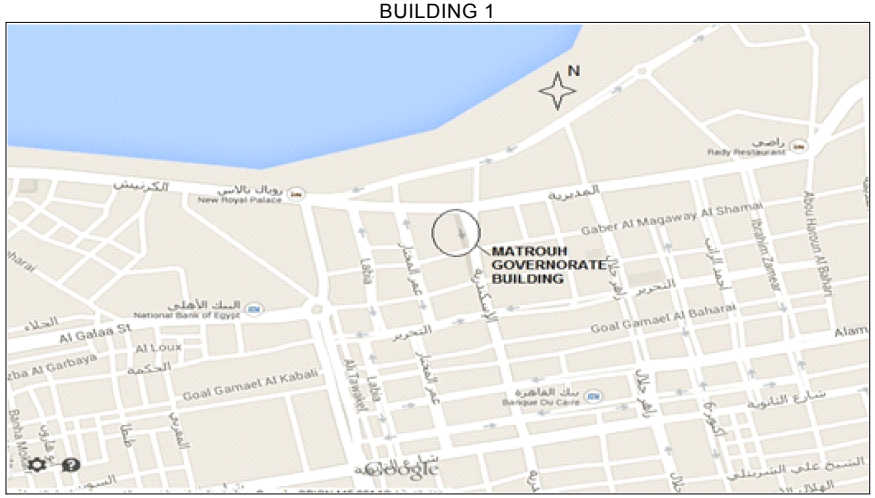
• The building permanent loads still not identified as the library was officially inaugurated on July 2014.

• The roof surface and orientation are suitable and a primary substructure as steel sheet is required which will be covered by 147 units of flexible thin film modules (5.4 x 0.4m).

• Local SMEs active in the field of RES will get experience from the operation of these innovative solar technologies and will be able to support them in the future.

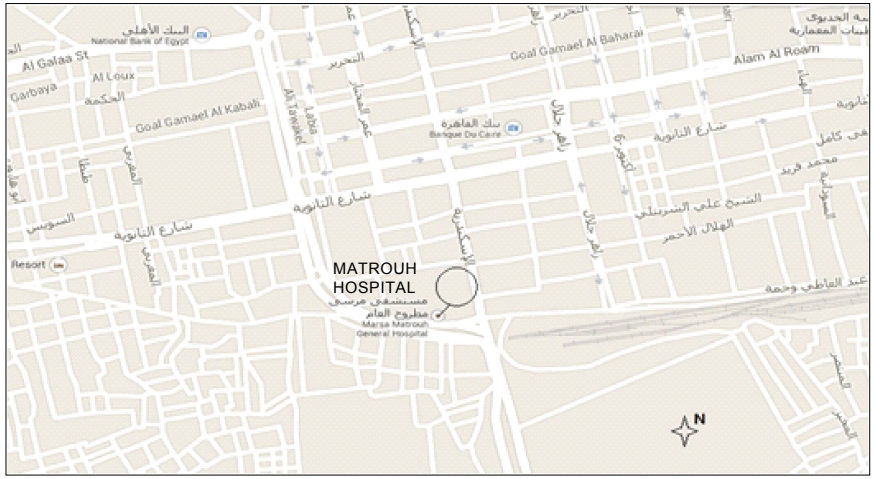
BIPV – Executive Project

BUILDING 1



BUILDING 2

BUILDING 3



BUILDING 4

DIDS LIT-PB

EAEE

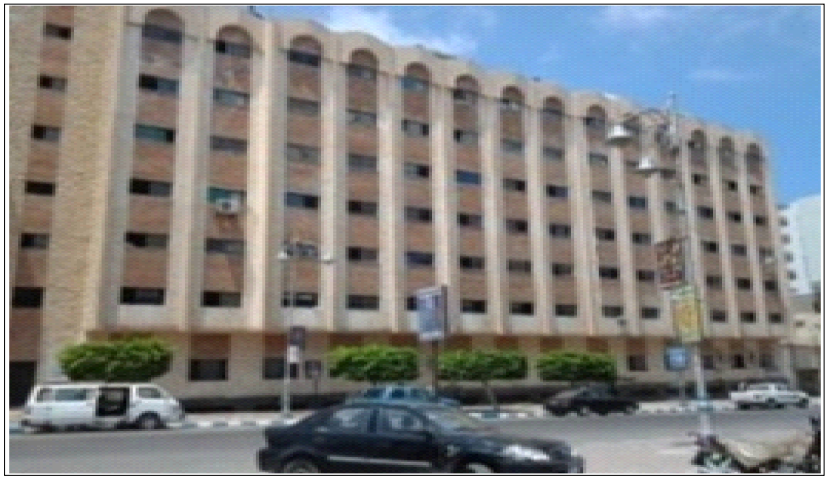
EORE

prepared : MAHMOUD	Aproved : Eng. Abd ELTWAB	Scale :
Project : Development & Implementation of Decentralized Solar Energy-Innovative Technologies for Public Buildings		Material :
		DATE: 10/11/2014
Title : LOCATION OF 4 BUILDINGS		Dwg No.: D1 Sheet No.: 1 / 2

BUILDING 1

BUILDING 2

BUILDING 3



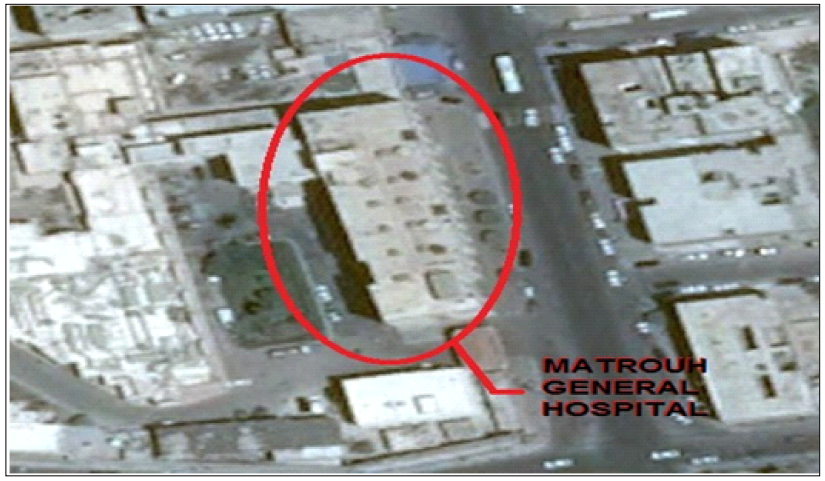
BUILDING 4

DIDS LIT-PB	prepared : MAHMOUD	Aproved : Eng. Abd ELTWAB	Scale :
	Project : Development & Implementation of Decentralized Solar Energy-Innovative Technologies for Public Buildings		Material :
EAEE			DATE: 10/11/2014
EORE	Title : LOCATION OF 4 BUILDINGS		Dwg No.: D1 Sheet No.: 2 / 2

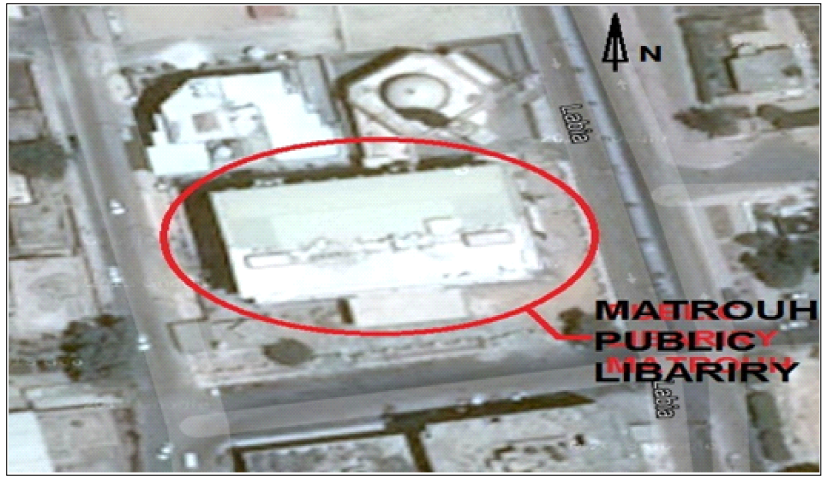
BUILDING 1

BUILDING 2

BUILDING 3

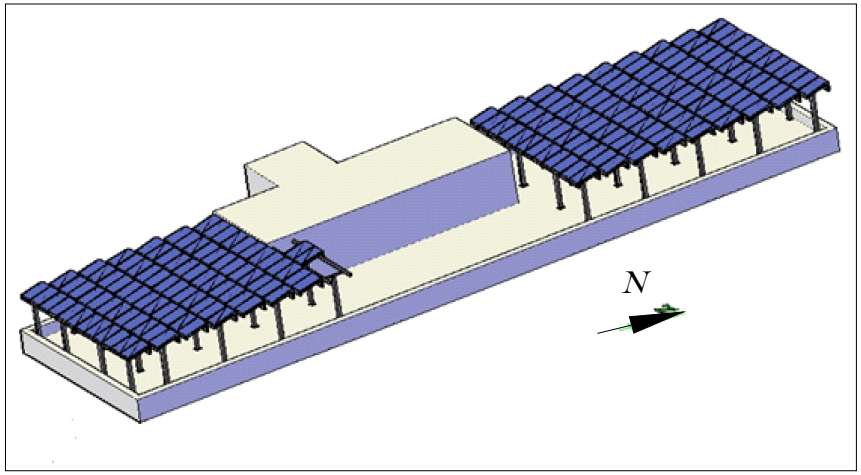


BUILDING 4

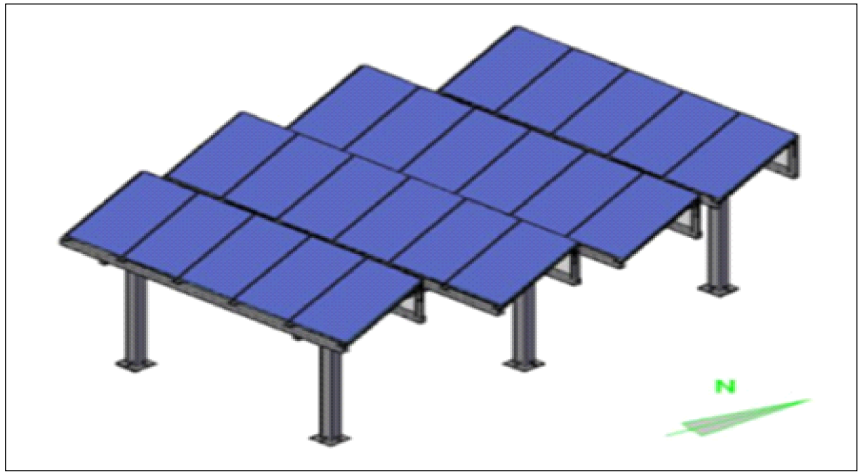


DIDS LIT-PB EAEE EORE	prepared : MAHMOUD	Aproved : Eng. Abd ELTWAB	Scale :
	Project : Development & Implementation of Decentralized Solar Energy-Innovative Technologies for Public Buildings		Material : DATE: 10/11/2014
	Title : SITE OF 4 BUILDINGS		Dwg No.: D2 Sheet No.: 1 / 1

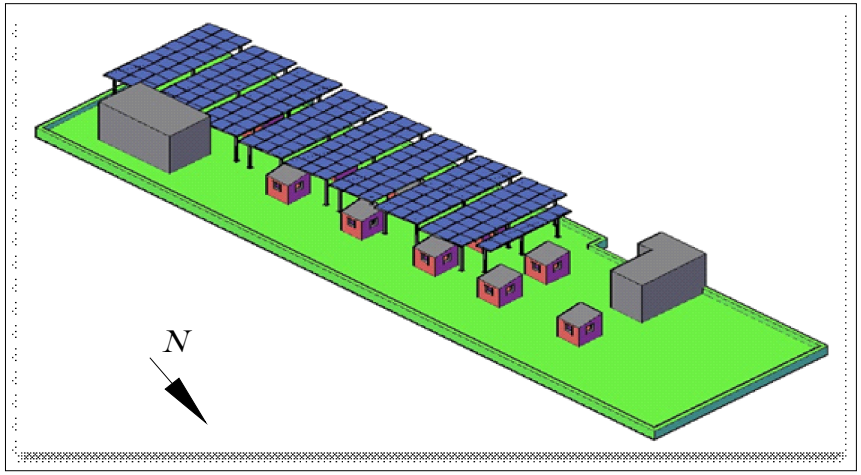
BUILDING 1



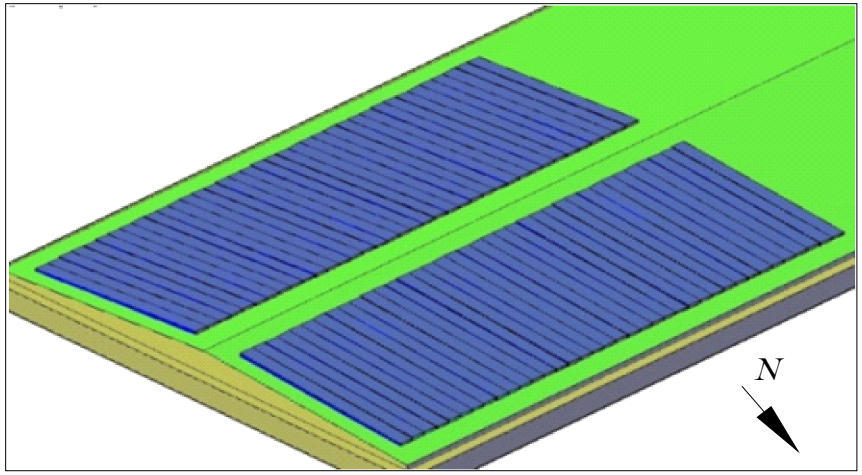
BUILDING 2



BUILDING 3

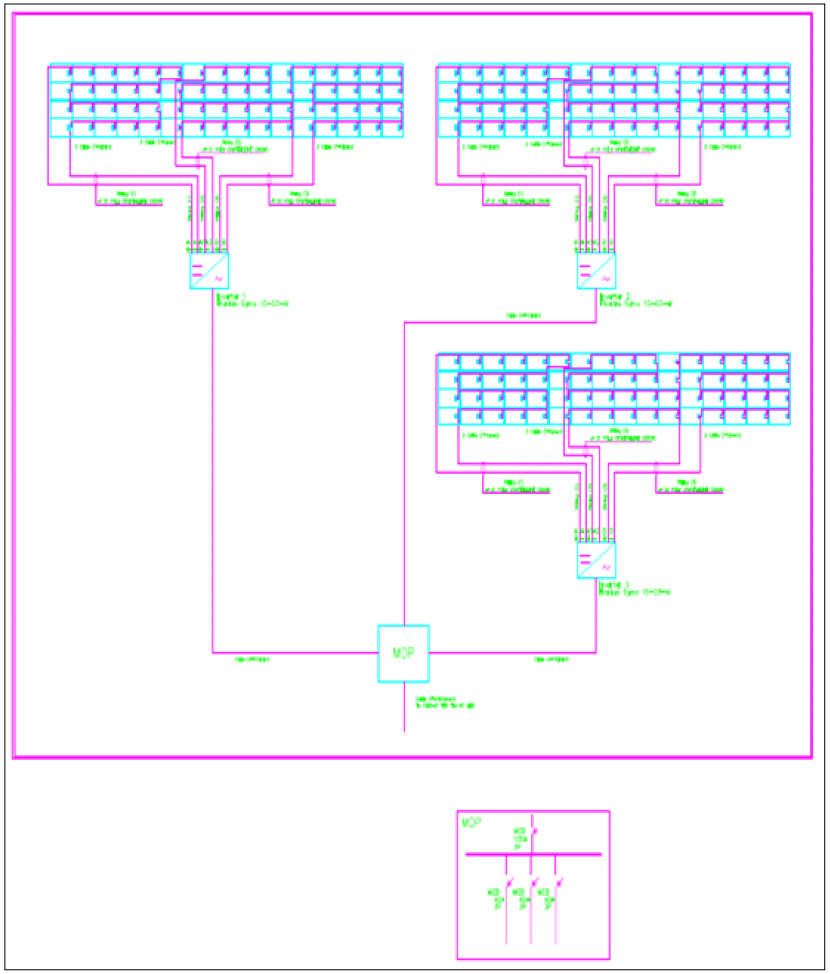


BUILDING 4

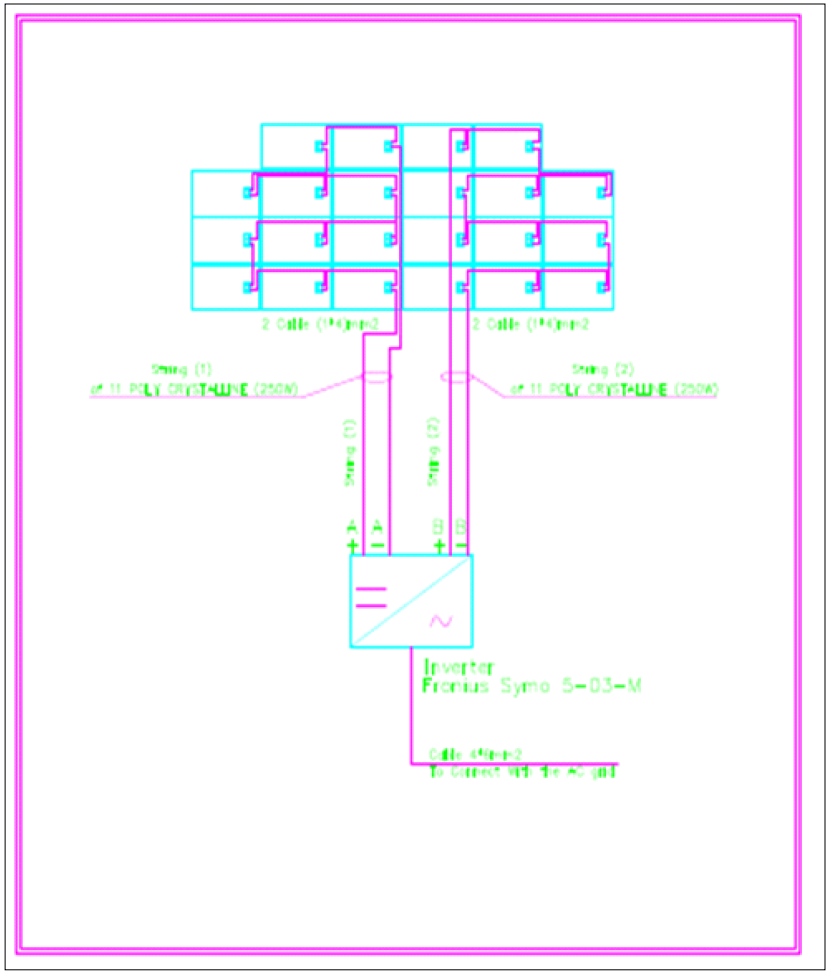


DIDS LIT-PB	prepared : MAHMOUD	Aproved : Eng. Abd ELTWAB	Scale :
	Project : Development & Implementation of Decentralized Solar Energy-Innovative Technologies for Public Buildings		Material :
EAEE			DATE: 10/11/2014
EORE	Title : GENERAL PLAN (PV MODULES LAYOUT) OF 4 BUILDINGS		Dwg No.: D3 Sheet No.: 1 / 1

BUILDING 1

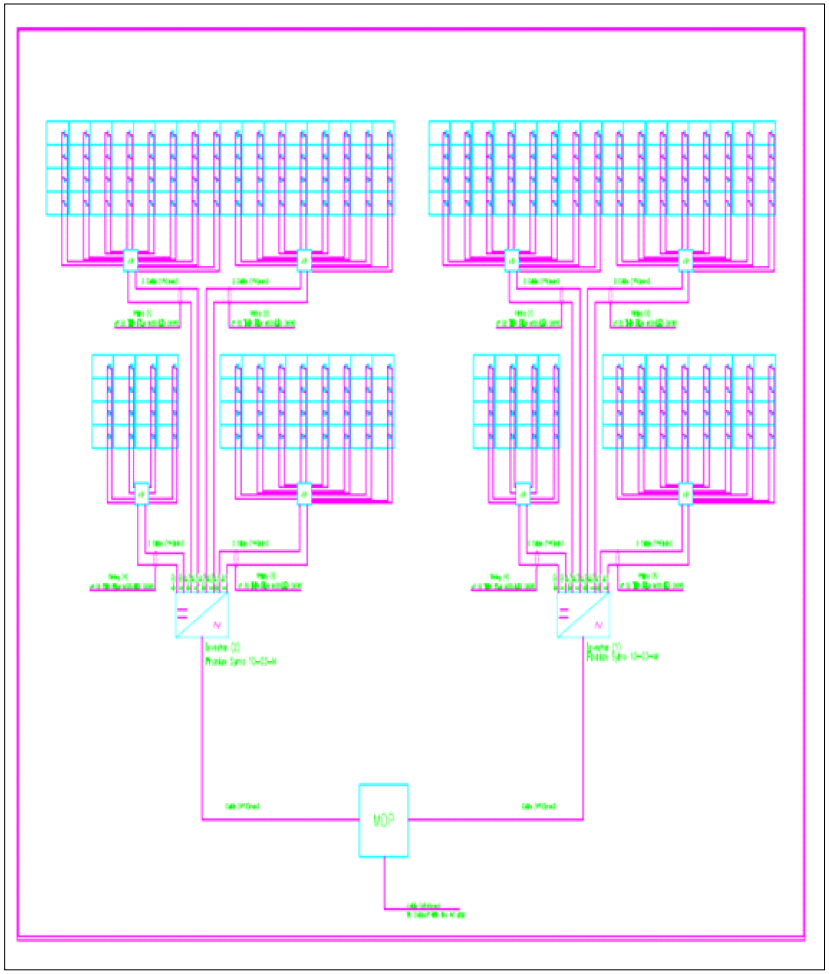


BUILDING 2

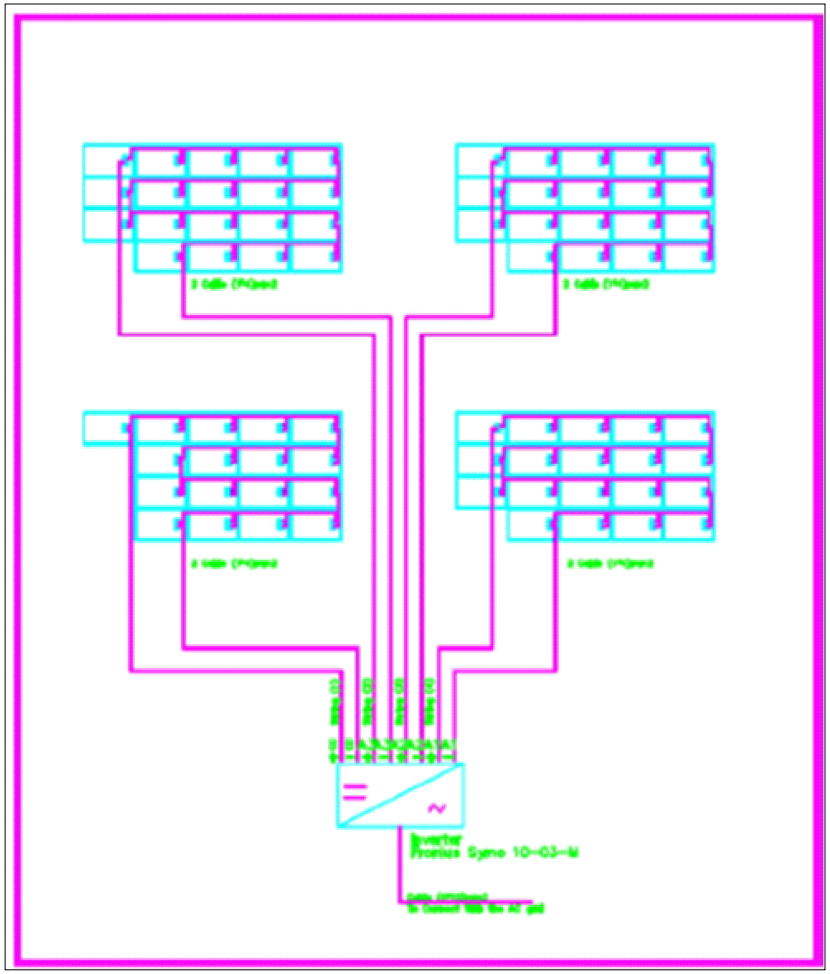


DIDS LIT-PB EAEE EORE	prepared : Hany Fekry	Aproved : Eng. BASAM ELMOGY	Scale :
	Project : Development & Implementation of Decentralized Solar Energy-Innovative Technologies for Public Buildings		Material : DATE: 10/11/2014
	Title : WIRING DIAGRAMS OF 4 BUILDINGS		Dwg No.: D4 Sheet No.: 1 / 2

BUILDING 3

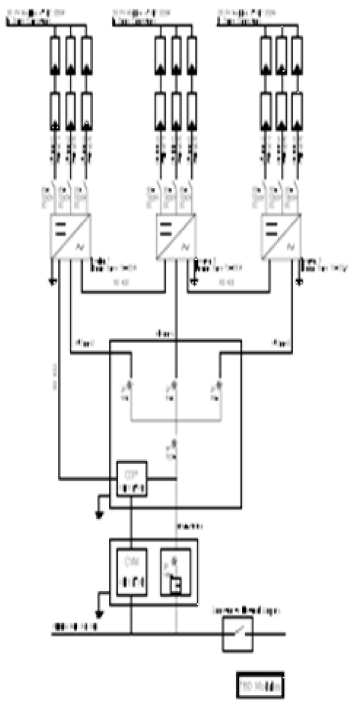


BUILDING 4

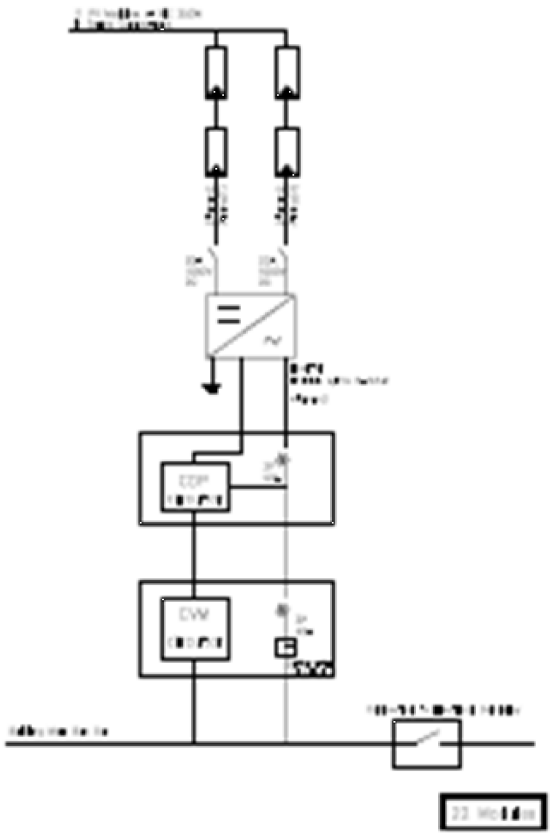


DIDS LIT-PB EAEE EORE	prepared : Hany Fekry	Aproved : Eng. BASAM ELMOGY	Scale :
	Project : Development & Implementation of Decentralized Solar Energy-Innovative Technologies for Public Buildings		Material : DATE: 10/11/2014
	Title : WIRING DIAGRAMS OF 4 BUILDINGS		Dwg No.: D4 Sheet No.: 2 / 2

BUILDING 1

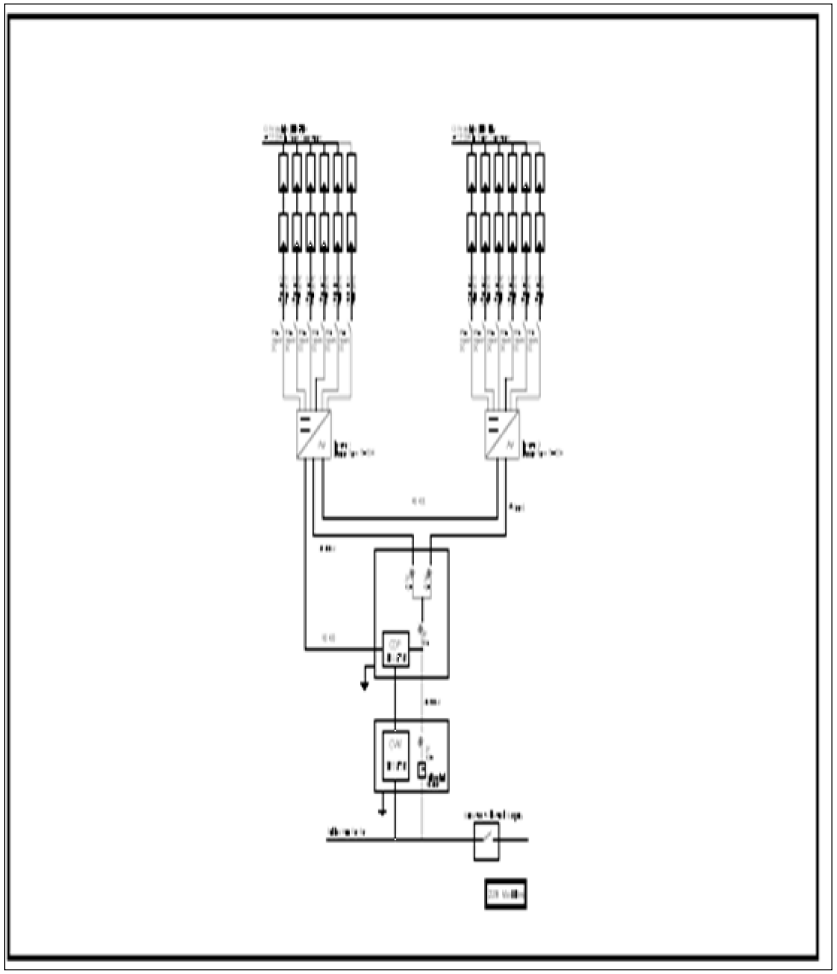


BUILDING 2

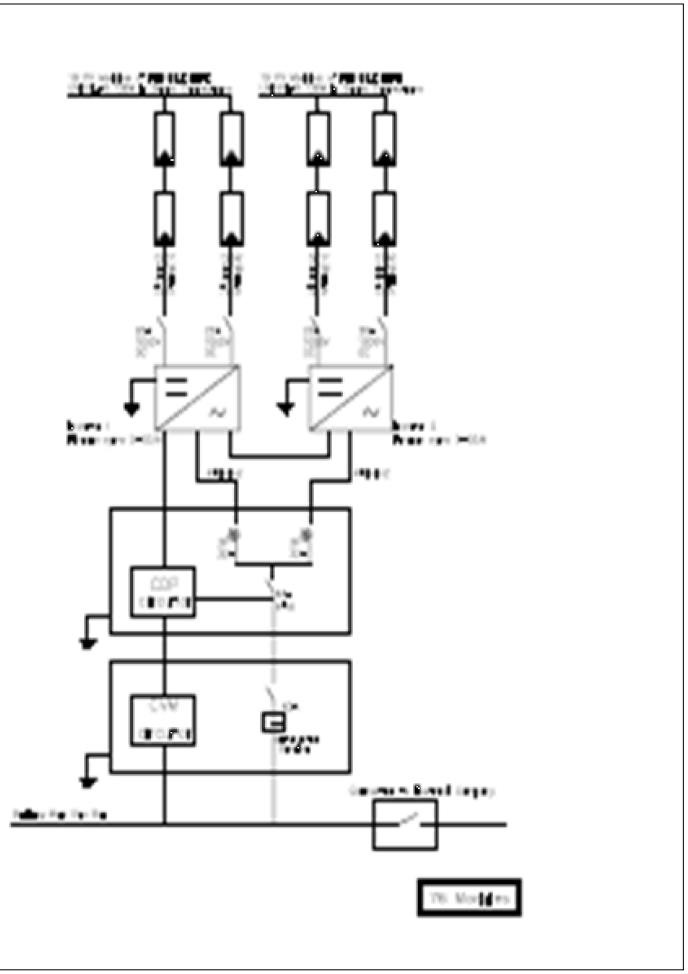


DIDS LIT-PB EAEE EORE	prepared : Hany Fekry	Aproved : Eng. BASAM ELMOGY	Scale :
	Project : Development & Implementation of Decentralized Solar Energy-Innovative Technologies for Public Buildings		Material : DATE: 10/11/2014
	Title : ELECTRICAL SINGLE LINE SCHEME		Dwg No.: D5 Sheet No.: 1 / 2

BUILDING 3



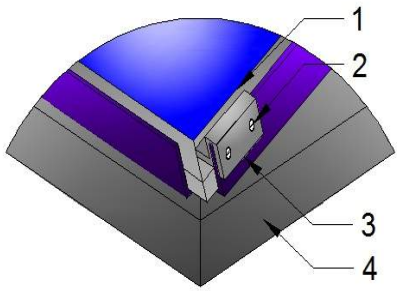
BUILDING 4



DIDS LIT-PB	prepared : Hany Fekry	Aproved : Eng. BASAM ELMOGY	Scale :
	Project : Development & Implementation of Decentralized Solar Energy-Innovative Technologies for Public Buildings		Material :
EAEE			DATE: 10/11/2014
EORE	Title : ELECTRICAL SINGLE LINE SCHEME		Dwg No.: D5 Sheet No.: 2 / 2

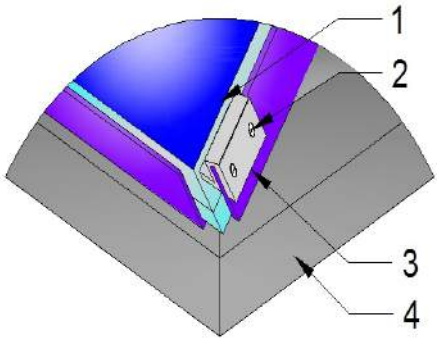
BUILDING 1

1- Module
2- Fixing bolt
3- Supporting angle
4- Pergola beam



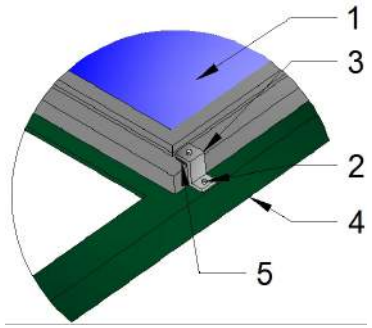
BUILDING 2

1- Module
2- Fixing bolt
3- Supporting angle
4- Pergola be



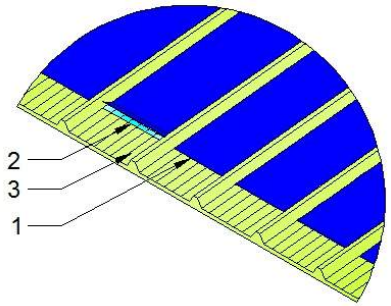
BUILDING 3

1- Module
2- Fixing bolt
3- Supporting angle
4- Pergola beam
5- Gasket



BUILDING 4

1- Module
2- Adhesive for installation
3- Roof



DIDS LIT-PB	prepared : MAHMOUD	Aproved : Eng. Abd ELTWAB	Scale :
	Project : Development & Implementation of Decentralized Solar Energy-Innovative Technologies for Public Buildings		Material :
EAEE			DATE: 10/11/2014
EORE	Title : CONSTRUCTION DETAILS		Dwg No.: D5 Sheet No.: 1 / 1

Project funded by the EUROPEAN UNION

ENPI CBCMED
CROSS-BORDER COOPERATION IN THE MEDITERRANEAN

DIDS LIT-PB

Egyptian Association for
Energy and Environment

PART 3

MEASUREMENTS

3. MEASUREMENT

In the Budget Chapter, the item should be grouped as follows:

3.1. LOT 1: Infrastructure

BOS 1	Chapter		Photovoltaic Main BoS Generation		Unit price	Total price
BOS1,1	Item	Ut	Three-phase inverter for grid connection, Fronius model 10000, 10000 W or similar, maximum power input, maximum input voltage 600 VDC, nominal output 10 100 W maximum power output VA 10160, maximum efficiency 97%. Supply and installation of three-phase inverter for grid connection , Fronius model 10000 or similar system applicable to control injection zero network controller CDP CIRCUTOR , 10000 W maximum power input , input voltage Maximum 600 VDC , nominal output 10 100 W maximum power output VA 10160 , maximum efficiency 97 % input, voltage range of 100 to 550 Vdc , dimensions 545x290x185 mm, with aluminum casing for installation indoor or outdoor installation, switch dc , graphic LCD , RS -485 and Ethernet controller digital sinusoidal current , ready for installation rail. Includes accessories required for proper installation. Fully assembled, connected and tested. Includes mounting , fixing and leveling and connections. Project measurement criteria : unit designed according to the graphic documentation of the project and the technical datasheet. Execution measurement criteria: We measured the number of units actually executed according to project specifications.	1,000		
BOS1,2	Item	ut	Supply and installation of photovoltaic glass laminated solar module for architectural integration into façade or roof. With polycrystalline/monocrystalline silicon cells and global transparency over 30-40% . Module parameters, according to project datasheet requirements. Vidur solar VS37 C54 P213, or similar, maximum power (Wp) 230 W, maximum power voltage (VMP) 29 V intensity at maximum power (Imp) 7.7 a, short-circuit strength (CSI) 8.3 a, open circuit voltage (Voc) 35.6 V , efficiency 14 % , 40 cells, 5mm tempered glass outer dimensions 1850x1200 , weight 60 kg, with junction box, mounting hooks. Includes execution of electrical wiring and equipment. Fully assembled, connected and tested. Includes junction boxes, cabling and MC3 connectors. Project measurement criteria: Area measured by graphic documentation of project, without duplicating corners or joints, minus all the gaps. Execution measurement criteria: We measured the surface actually executed according to project specifications, without duplicating corners or joints , minus all the gaps.			
Total of LOT (1)						

3.2. Measurements list
LOT 2: Services

BOS 2	Chapter		Secondary Structure	Unit price	Total price
BOS 2.1	Item	m	Rigid ground wire cable, bare, twisted 16mm ^{2} section. Supply and installation of ground conductor cable consisting of rigid bare twisted cable of 16 mm ^{2} section. Also w / w welded joints made "afumex" bonding clamps and terminals. Completely assembled and tested with established connections. Includes: redesigning the route, ground conductor, wiring terminals through the ground conductor junction. Project measurement criteria: graphic documentation according to specifications of the project. Execution measurement criteria: We measured the cable length that was actually executed according to project specifications.		
BOS 3	**Chapter**		**General BOX**		
BOS 3.1	Item	Ut	General Safety protection box, with connection terminals, unipolar bases with fuses capable of maximum intensity of 160 A.		
			Supply and installation of general protection box inside wall niche, with connection terminals and unipolar bases with fuses capable of maximum intensity of 160 A to protect the general supply line of d, protected with envelope insulation, sealed and self-ventilated. Degree of flammability as indicated in low voltage regulations. Degree of protection IP 43 IK 08 according to low voltage regulations, with closed door metal protection having degree of protection IK 10 according to low voltage regulations and protected against corrosion, with lock or padlock. Normalized by the supplier and prepared for underground service connection. Includes fasteners and connection with the conduct of buried grounding. Fully assembled, tested and connected. Includes: Stake situation ducts and anchors the box. Fixing the frame. Placing the door. Placement of tubes and special pieces. Connections. Project measurement criteria: unit designed according to graphic documentation of the project. Execution measurement criteria: We measured the number of units actually executed according to project specifications.		
BOS 3.2	Item	Ut	Safety measurement with current transformer CMT-300E, up to 300 A. intensity for phase 1 meter, installed inside wall niche in family house or premises.		
			Supply and installation inside wall niche – new or existent -of current transformer measure box, CMT- 300E , up to 300 A in intensity by 1 meter phase , with envelope insulation, sealed , and self-ventilated with peepholes covered by transparent material resistant to the		

			action of ultraviolet rays. Includes complete measuring equipment, terminals, fuses and circuit breaker rules for protection. Authorized by the supplier and prepared for underground service connection. Fully assembled, tested and connected. Includes: Stake situation ducts and anchors. Fixation. Placement of tubes and special pieces. Connections. Project measurement criteria: unit designed according to graphic documentation of the project. Execution measurement criteria: We measured the number of units actually executed according to project specifications.		
BOS 4	**Chapter**		**Simple electrical PV evacuation**		
BOS 4.1	Item	m	Single-phase shunt fixed surface for general services, consisting of unipolar cables with copper conductors, RZ1-K (AS) 5G6 mm ^{2}, and its assigned voltage of 0.6 / 1 kV PVC with channel protector of 30x60 mm Supply and installation of single-phase shunt fixed for general service area bounded between the meter and the centralization of protection and safety measures and dashboard and protection of each user, comprising unipolar cables with copper conductors, RZ1 -K (AS) 5G6 mm ^{2}, and its assigned voltage 0.6 / 1 kV PVC with channel protectors of 30x60 mm. Includes w / w accessories, fasteners and thread control for exchange rate. Fully assembled, tested and connected. Includes: Stake and layout of the line. Laying and fixing channel. Cable laying. Connections. Project measurement criteria: graphic documentation as measured according to length of the project.Execution measurement criteria: We measured the length actually executed according to project specifications.		
BOS 5	**Chapter**		**BOS-BOX. Inverter and Electrical Protections**		
BOS 5.1	Item	Ut	General box control and protection for photovoltaic system		
			Supply and installation of control and overall picture protection for photovoltaic system. Includes 2 MCB's devices and differential protection circuitry Includes: Stake. Assembly of all components. Criteria for measuring project: unit designed according to graphic documentation of the project. Criterion measure of work: We measured the number of units actually executed according to project specifications.		
BOS 5.2	Item	Ut	Electrical distribution network for photovoltaic installation up to 60 m^2 ,with interior wiring circuits under protective tube or flexible channel protectors (PVC plastic).		

			Supply and installation of electrical distribution network for photovoltaic panels of. Includes: protective tube of flexible PVC or corrugated pipe for laying surface cables inside, junction boxes with covers and strip connection boxes, and recessed screws and several accessories necessary for proper installation. Fully assembled, tested and connected. Includes: Stake and tracing. Laying and fixing pipes. Laying cable and cable connections. Placing mechanisms. Criteria for measuring project: unit designed according to graphic documentation of the project. Criterion measure of work: We measured the number of units actually executed according to project specifications.		
BOS 6	**Chapter**		**Structure**		
BOS 6.1	Item	m^2	Secondary self-supporting metallic structure. Supply and installation of metal frame covered with self-supporting secondary structure, comprised of steel profiles, hot rolled and cold formed galvanized sections C and "omega U". Also w / w of anchor elements. Fully executed. Includes: Stake and marked axes. Fixing and presentation of the structure by crane. Plumb. Resolution unions. Set-pieces and the final adjustment of the joints between the different components of the structure (pairs, belts, straps, etc.).. Criteria for measuring project: unit area measured according to graphic documentation of the project. Criterion measure of work: We measured the area in real size according to project specifications.		
BOS 6.2	Item	m^2	Self-supporting steel structure, in primary structure or deck. Metal structure made of rolled steel S275JR, L<10 m separation of 4 m between frames		
BOS 7	**Chapter**		**Air-Conditioners**		
BOS.	ut		Supply and installation of 30 units A/C 5kW cooling each together with interior split fan coil, cables, protection, gas charge, electrical box, etc...		
BOS 8	**Chapter**		**Labour**		
BOS 8.1	Item	ut	Included in BOS 1,2 and BOS 7		
BOS 9	**Chapter**		**Transport**		

BOS 9.1	Item	ut	Transport of PV materials		
MON	**Chapter**		**Monitoring**		
MON 1	Item	Ut	Control unit type CDP Circutor or similar. · Includes 2 sets flex clamps and network analyzer CVM hair type, indoor and outdoor display screens, digital camera. Supply and installation of central control CDP type Circutor control systems for self consumption and grid connected. Fully assembled and tested wiring. Includes: Stake. Laying and fixing elements. Established connections with the mains. The system will allow the integration included in this offer licensed software set to a SCADA system. This system should integrate CDP peripheral control and display real-time power and energy variables and the number of circuits activated. The programming software must be on SCADA screens Create Combining Different parameters from CIRCUTOR or similar communications equipment connected to the network, and simulate energy bills. The software must generate reports for the allocation of energetic costs, and manage and control events using programmed ALARMS by use of automated processes. Every installation, no matter where it is, must use an IP connection for the system to be integrated in a central SCADA. The system must include the following: - 3 phase inverter E1336E or similar - Dynamic Power Controller E51001 CDP-0 or similar - Energy Manager M61010 EDS, or similar - Power Analyzer M52081 CVM, or similar - Current Transformers M73122 MC-125, or similar - Current Transformer M73121 MC-63, or similar - Current Transformer M73123 MC-250, or similar - In Door Screen - Out Door Screen - Camera		
BOS 10	**Chapter**		Training		
BOS 11	**Chapter**		2 years maintenance during the Guarentee period		
BOS 12	**Chapter**		Recommended spare parts for 3 years of operatioon after the guarentee period		
BOS 13	**Chapter**		Transport		
PRO	**Chapter**		Project & legalization		
PRO1	Item	Ut	4 visits to the project sites , located at Matrouh city, during the installation, commissioning and warranty period. Includes the travel to the facility.Criteria for measuring project: Estimation based on the size of the work.		
Total of LOT (2)					

Project funded by the EUROPEAN UNION

ENPI CBCMED

DIDSOLIT-PB

Egyptian Association for
Energy and Environment (EAEE)

ANNEX 2

BIPV-PROJECT TECHNICAL SPECIFICATIONS

Executive Project content

WWW.DIDSOLIT. EU

SUMMARY

1 Object 1

2 Generalities 1

3 Definitions 1

3.1 Generics 1
3.2 Installation 1
3.3 Modules 2
3.4 Architectonic integration 3

4 Design 4

4.1 Photovoltaic generator 4
4.2 Monitoring system 4
4.3 Architectonic integration 5

5 Components and materials 5

5.1 Generalities 5
5.2 Photovoltaic generators 6
5.3 Support structure 7
5.4 Inverters 8
5.5 Cables 9
5.6 Connection to grid 10
5.7 Grounding system 10
5.8 Harmonics and Electromagnetic compatibility 11

6 Reception and tests 11

7 Technical requierements of maintenance contract 12

7.1 Generalities 12
7.2 Maintenance Program 12
7.3 Guarantees 14
7.3.1 General scope 14
7.3.2 Terms 14
7.3.3 Economic Conditions 14
7.3.4 Annulment of guarantee 15
7.3.5 Place and Time of Service 15

1. OBJECT

To establish the minimum technical conditions to be met by solar photovoltaic solar installations connected to the grid.

This document is intended to serve as a guide for manufacturers and installers of equipment, defining the minimum specifications to be met by the installation to ensure its quality, for the benefit of the user's own development of this technology. Compliance with this Technical Specification is subject to the criteria determined by the technical director of the work or by the project management following the specifics of the installation.

It assesses the final quality of the in terms of performance, production and integration.

The scope of this Project Technical Specification (in what follows, PTS) covers all mechanical, electrical and electronic parts of the installations.

In certain cases for the projects, these may adopt, due to the very nature or by technological development, different solutions to those required in this PTS, provided that the need is sufficiently justified and that it does not involve a reduction in the minimum requirements of quality specified herein.

2 GENERALITIES

This Technical Specification describes the integrated application of all the photovoltaic installations directed for the production of electricity for sale in its entirety to the distribution grid or local consumption.

3 DEFINITIONS

3.1 Generics

Solar radiation

Energy coming from the sun in the form of electromagnet waves.

Irradiance

Power density incident on a surface or the energy incident on a surface per unit time and unit area measured in kW/m^2.

Irradiation

Energy incident on a surface per unit area and over a certain period of time measured in kWh/m^2.

3.2 Installation

Photovoltaic installations

Those provisions of photovoltaic modules that convert sunlight directly into electricity without any intermediate step.

Interconnected photovoltaic installations

Those that usually work in parallel with the distributor company.

Connection line and point, and measurement

The connecting line is the line through which electricity is connected form the photovoltaic installations to a grid point from the distribution company or with the connection of the user, called connection point and measure.

Automatic Switch of the Interconnection

Automatic switch device on which the protections for interconnection act

General Switch

Safety and manoeuvre device that allows separating the photovoltaic installation from the local grid or the distributor.

Photovoltaic Generator

Parallel association of photovoltaic branches.

Photovoltaic Branches

Subset of interconnected modules in series or in parallel-series associations, with voltage equal to the voltage of the generator.

Inverters

Converter of voltage and current alternating current and voltage.

Nominal power of the generator or peak power

Sum of the maximum power of the photovoltaic modules.

Power of photovoltaic installation or nominal power

Sum of the nominal power of inverters (specified by the manufacturer) involved in the three phases of the installation at nominal operating conditions.

3.3 Modules

Solar or photovoltaic cells

Device that transforms solar radiation into electrical energy.

Technology equivalent cells

Independent solar encapsulated cell, the technology of which the manufacturing and packaging is identical to that of photovoltaic modules that comprise the installation.

Photovoltaic module o panel

Set of solar cells directly interconnected and encapsulated as a single block, among materials that protect it from the effects of weather.

Standard Measurement Conditions (STC)

Terms of irradiance and temperature in the solar cell, universally used to characterize cells, modules and solar generators and defined as follows:

- ✓ Solar irradiance: 1000 W/m^2
- ✓ Spectral distribution: AM 1,5 G
- ✓ Cell temperature: 25 °C.

Peak Power

Maximum power of the photovoltaic panel in STC.

NOTC (Nominal Operating Temperature of the Cell)

Nominal Operating Temperature of the Cell, defined as the temperature that the solar cells reach when they are subjected to to irradiance of 800 W/m2 with spectral distribution AM 1,5 G, ambient temperature of 45 °C and wind speed of 1 m/s.

3.4 Architectonic integration

According to the cases involved, the following applications will be applied:

Architectonic integration of the photovoltaic modules

When PV modules fulfill a dual function, energy and architecture (siding, fencing or shading) and, in addition, replace conventional building elements.

Siding

When PV modules are part of the envelope of architectural construction.

Closure

When the modules are the roof or the facade of the building's architecture, having to ensure proper sealing and insulation.

Elements that cause shades

When the photovoltaic modules protect the architectural construction from thermal overload caused by the sun's rays, providing shade on the roof or in front of it.

The placement of parallel photovoltaic modules in the envelope of the building without the dual functionality defined will be called overlay and will not be considered as architectural integration. Horizontal modules within the concept of overlapping will not be accepted.

4 DESIGN

4.1 Photovoltaic generator

The photovoltaic module selected will meet the specifications in section 5.2.

All modules that integrate the installation will be of the same model, or in the case of different models, the design must ensure full compatibility between them and the absence of negative effects on the installation due to this reason.

In the particular case of an installation consisting of two types of modules, each module should be the same inside.

In those rare cases where non-qualified modules are used, this must be duly justified; information about the tests and trials that have been submitted must be presented. In any event, any product that does not meet any of the above specifications must have the express approval of Project Management (PM). In all cases, current mandatory standards must be followed.

4.2 Monitoring system

- Monitoring System must fulfill the following requirements and the ones detailed at the *"Executive Project " (EP)* and the *"Project Technical Specifications" (PTS).*

- The monitoring system should enable to read the following parameters:

  - PV production of the different PV fields
  -Energy consumption of the electrical load connected to the PV field
  -Total energy consumption of the building
  -CO2 avoided
  -Power quality supplied to the load
  -Grid power quality
  -Export-import capacity; and, the total energy consumption on the building.

- The parameters can be displayed via the Internet with the data required to be displayed on a screen for the public. All the necessary materials for installation should be included (rs485 cable, software, computer, protections, camera, etc.).
- Ability to communicate with various brands of inverters, and record the readings of peripheral equipment that is analyzed.
- All monitoring system works with the central websites, so that the information can be retrieved from any computer with an Internet connection via an intranet. All inverters will have XML programming, in order they can operate in the central server of the DIDSOLIT project.
- The system must be able to link with each local web server and program a global environment with all the facilities.

- Every installation will have a data logger to connect with de central DIDSOLIT server. The data logger and the controller should have the capability to work with different inverters and open systems.
- At the end of the project, the Contractor shall supply hard and soft copies of the monitoring principles and PLC programs of the 4 buildings.
- Inverters must fulfill the requirements detailed in the *"Executive Project " (EP)* and the *"Project Technical Specifications" (PTS).*

4.3 Architectonic integration

In the case for trying to perform an integrated installation from the architectural point of view.

The conditions of construction refers to the study of urban characteristics, implications for the design, construction performance, the need for renovation or expansion, structural inspections, etc. that, from the point of view of a competent professional in construction, requires his/her intervention.

The terms of the installation refer to the visual impact, modifications in the conditions of the building, the need to enable new areas or expand the volume of construction, effects on the structure, etc.

In any case, the PM may require a report on architectural integration with the corrective measures to be taken. The ownership of the building itself or by delegation, certify and report on compliance with the requirements.

When necessary and following the PM's criteria, the report on architectural integration that specifies the urban and architectonic characteristics, the conditions considered for inclusion in the integration, and the corrective measures to be included in the project's structure will be attached to the Design or Project Report.

5 COMPONENTS AND MATERIALS

5.1 Generalities

As a general principle, it will be necessary to ensure at least a basic Class 1 degree of electrical insulation regards both equipments (modules and inverters) and materials (conductors, boxes and connection boxes) excepting the continuous wiring, which will be of double insulation.

The installation will include all the elements and features necessary to ensure the quality of electricity supply at all times

The performance of photovoltaic installation shall not lead to grid failures, reductions in security or alterations superior to that which the relevant regulations admit.

In addition, the operation of these installations shall not give rise to hazardous work conditions either to the maintenance staff or to the staff involved in the exploitation of the distribution grid.

The materials exposed to the weather will be protected against environmental agents, particularly against the effects of sunlight and moisture.

All the necessary elements for security and protection of the persons and photovoltaic installations will be included, ensuring protection against direct and indirect contacts, short circuits, overloads, as well as other elements and protections called for in the application of existing laws.

Any changes that occur with respect the Application, and the motives for these, will be highlighted in the Design or Project Report. Furthermore, photocopies of the technical specifications provided by the manufacturer of all components will be included.

For security purposes and operation of equipment, the indicators, labels, etc. will be in English language at the installation site.

5.2 Photovoltaic generators

All modules must meet the UNE-EN 61215 specifications for Crystalline Silicon Modules or UNE-EN 61646 for Thin Film Photovoltaic Modules, as well as be certified by a recognized laboratory (for example, New and Renewable Energy Agency, NREA, etc.), which will give its accreditation by way of presenting the relevant official certificate.

The photovoltaic module will make clearly visible and indelible the model and manufacturer's name or logo, as well as the individual identification or serial number traceable to the date of manufacture.

Modules that conform to the technical specifications described below will be used. For any deviations from these characteristics, in exceptional cases, these must be presented in the Application, together with the justification, and must get approval by the PM.

Flashtests of all the modules must be sent to the PM so that the PM can determine the groups to be formed so as to avoid mixing modules with large dispersion of the technical characteristics (especially the short-circuit current). The installer will respect all the groups specified by the PM.

The modules should carry the bypass diodes to prevent possible damage to the stem cells and their circuits for partial shading and have a degree of protection IP65.

The side frames, if any exist, shall be made of aluminium or stainless steel.

For a module to be acceptable, its maximum power and short circuit conditions relating to real standard should be comprised having the margin of ± 5% of nominal values in the corresponding catalogue (other margins can be accepted under specific circumstances).

Any module that shows manufacturing defects such as cracks or stains on any of its elements or a lack of alignment in the cell or bubbles in the encapsulant will be rejected.

High efficiency cells will be positively valued.

The structure of the generator is connected to the grounding.

For security reasons and to facilitate the maintenance and repair of the generator, the necessary elements (fuses, switches, etc.) will be installed for disconnection - independently and in both terminals - from each one of the branches in the rest of the generator.

5.3 Support structure

Support structures must comply with the specifications of this section.

Otherwise, a justification of the points of non-compliance must be included in the Application and in the Design or Project Report. Acceptance of these must get expressed approval by the PM.

The support structure must be able to withstand, with the modules installed, overloading caused by wind and snow, in accordance with Technical Code of Buildings (TCB).

The design and construction of the structure and the fixing of the modules will allow the necessary thermal expansion without transmitting loads that may affect the integrity of the modules, following the manufacturer's instructions.

The mounting points for the photovoltaic module will be sufficient in number, taking into account the area of support and relative position, so there is no bending in the modules beyond that permitted by the manufacturer and by certified approved methods for the model of the module.

The design of the structure will be made for the orientation and angle of inclination specified by the photovoltaic generator, taking into account ease of assembly and disassembly, and the possible need for replacement items

The surface structure is protected against the action of environmental agents.

Drilling in the structure will be made prior to assembly, if necessary, in view of the galvanization or protection of the structure.

The screws shall be made of stainless steel, complying with the Egyptian standard MV-106. In the case of a galvanized structure, galvanized screws can be allowed, except when the modules are subjected to the same structure, where stainless steel screws will be used.

The buffer clamping modules and the structure itself does not cast shade over the modules.

In the case of indoor installations that also provide cover to the building, the design of the structure and water tightness between modules will conform to the requirements of the Technical Code of Buildings. In the same way, there must be a guarantee to ensure no condensation on the inside of the glass is produced during normal operation where it is located.

The necessary support structures for mounting the modules will exist, both for the flat surface (terrace) and for those integrated on the roof. All accessories and benches and / or anchors will be included.

The support structure is calculated according to the TCB standard MV-103 to withstand extreme loads due to adverse climatic factors such as wind, snow, etc.

If it is constructed using cold formed rolled steel, it must meet the TCB and the standard MV-102 to ensure all its mechanical properties and chemical composition.

If the support type is galvanized, it must be a minimum thickness of 80 microns to eliminate maintenance requirements and prolong its life.

5.4 Inverters

These will be a type sufficient for connecting to the grid, having a variable input power that enables them to be able to extract the maximum power the photovoltaic generator can provide each day at all time.

The basic characteristics of the inverters are the following:

- Principle of operation: current source
- Self-commutated
- Automatic monitoring from maximum power point of the generator
- Anti islanding or in a isolated way

The inverters will comply with EU directives on Electrical Safety and Electromagnetic Compatibility (both will be certified by the manufacturer), incorporating protections against:

- Short circuits in alternates
- Mains voltage out of range
- Grid frequency out of range
- Surge in varistors or similar
- Disturbances present in the grid such as mini-shorts, pulses, cycle defects, absence and return to the grid, etc.

Each inverter will have the necessary indications or signs for proper operation and will incorporate the automatic controls necessary to ensure its proper use and supervision.

Each inverter will include at least the following manual controls:

- General on and off of the inverter.
- Connection and disconnection of the inverter interface AC. This can be external to the inverter.

The electrical characteristics of the inverters are as follows:

- Inverters should be a recognized brand and carry identification of origin, meeting the standard "Rule of Origin" and having the EC trademark of the European Community.
- Range of powers between 1kWe 30 kWe
- DC input voltage up to 1,000 V
- The inverter will deliver power to the grid continuously in terms of solar irradiance 10% higher than the STC. Also, it will withstand spikes of magnitude higher than the 30% STC for periods of up to 10 seconds.

- Maximum efficiency not less than: 88% (inverters less than 5 kW), 95% (inverters over 5 kW).
- The power factor of the power generated will be greater than 0.95, between 25% and 100% of the nominal power.
- The inverters consumption in night mode should be less than 0.5% of its nominal capacity.
- Protection against: short-circuit, reverse input polarity, overload, overheating, over frequency, under frequency, over voltage and under voltage, residual current protection.
- The inverters will have a minimum IP20 of protection in the interior of buildings to inaccessible sites, and an IP30 in the interior of buildings to accessible sites, and IP 65 for inverters installed outdoors. In any case, they all must comply with current legislation
- Must meet the requirements of the Low Voltage Regulation.
- Must have rejection or filtering of harmonic distortion, according EN 61000-3-12
- Protection against bad weather
- Open Communication MBus and Connect with a control device able to block the injection to the Grid, according to the Project specifications.
- Data logger possibilities with Ethernet capabilities.
- Monitoring system :

  -The system shall continuously collects all the data from the inverters on the system side and keeps information of the system's status at any given time.

  -The system should have energy-efficient data logger, archiving and processing data and security regulations in networks.

  -Inverter shall have remote monitoring, diagnosis and configuration of the solar power plant from anywhere through web based application.
- Capability to be connected to external sensors for monitoring environmental conditions.
- Guaranteed to operate from 0º to 50ºC temperature and between 0% and 85% relative humidity.
- Power Factor Adjustable
- THD < 3% nominal apparent power
- Inverter shall ensure easy localization of internal inverter failures, warnings and alarm shall be forwarded to the control and monitoring system.Supplier shall submit a list of proposed settings as warning or alarm for failures for approval

5.5 Cabling and Connection boxes

- The positives and negatives of each group of modules will be led in separate cables (unipolar cables) and protected according to the legislation. The positive and negative will be lead together as much as possible making sure these do not to create magnetic fields that can attract lightning.
- All AC and DC lengths of cable will be included. These must be of the necessary length to avoid generating efforts by the different elements and exclude the possibility of interfering with people during normal pedestrian traffic.

All continuous wiring shall have double insulation and be suitable for outdoor use, in the open air or underground.

- The connection boxes operate in both two technologies (thin film and crystalline), into low voltage, (AC &DC) current. In order to fulfill the legal low voltage requirements, the following material and devices have to be included:

AC Field:

- General AC breaker (maximum current for each case to study)
- Differential switch circuit breaker 300mA
- VP Class II Overvoltage transient protection
- AC circuit breaker inverter protection
- AC circuit breaker 4A for handling current devices
- AC IP 65 Box (metallic or plastic)
- Data logger included with the electrical wiring (5 modules space minimum necessary)
- Data analyzer (2 units) with the electrical wiring(6 modules space minimum necessary)

DC Field:

- DC VP Class II Overvoltage transient protection per inverter circuit (string)
- Differential switch circuit breaker 30mA per general inverter circuits
- DC swich disconnector per inverter circuit (String)
- Protection Fusses per inverter circuit (string)
- Inverse relay current per inverter (included all inverter circuits)
- DC IP 65 Box (metallic or Plastic)

5.6 Connection to grid

Isolation switch

- The system must contain two isolation switch (DC/AC switches) which can isolate the PV system from the building electrical network .
- The isolation switches shall be mounted near the building electric grid connection point.
- The DC isolating switches shall be 1000V DC.

5.7 Protection and Grounding system

- In three-phase connections to the grid, the protections for the interconnections at each phase will be maximum and minimum frequency (51 Hz and 49 respectively) and maximum and minimum voltage (1.1 um and 0.85 um respectively).
- **Grounding requirements**
  - Earthing system design should be as per the standard practices.

- PV array, DC equipment,inverter, AC equipment and distribution wiring shall be earthing as required.
- Equipment Earthing shall connect all non-current carrying metal receptacles, electrical boxes, appliance frames, chassis, and PV panel mounting structures in one long run. The earthing wire should not be switched fused or interrupted.
- Earthing system shall be electrically connected to provide return to earth from all equipment independent of mechanical connection.
- System earthing network shell be connected to building network after doing the needed teats

- When the galvanic isolation between the low voltage distribution grid and the photovoltaic generator is not performed by an isolation transformer, the items used to ensure this condition will be explained the Design or Project Report.
- All masses of the photovoltaic installation, both the continuous section and the alternates, will be connected to a single grounding. This grounding will be independent of the Distribution Company, in accordance with the Low Voltage Regulation.

5.8 Harmonics and electromagnetic compatibility

- Grid disturbance limitation
- DC injection < 20mA.
- Limit of harmonics according EN 61000-3-12.

6 Reception and tests

The installer will give the user a document-delivery note indicating the supply of components, materials and the user manuals for the installation and its maintenance. This document will be signed in duplicate by both parties, each retaining a copy. The manuals will be delivered to the user in English language to facilitate proper interpretation

Before the commissioning of all major elements (modules, inverters, meters), these shall have passed the performance tests at the factory. The record of these tests will be attached to the quality certificates.

The tests to be carried out by the installer, regardless of any indicated previously in these PTS, will cover at minimum the following:

- Operation and commissioning of all systems.
- Tests for starting and stopping at different moments of operation.
- Testing of components and protective measures, security and alarm, as well as their performance, with the exception of the tests relating to the automatic switch-off mechanism.

Upon completing the testing and implementation phase, the work will enter the Provisional Acceptance stage. However, the Provisional Acceptance Certificate will not be signed until all systems and elements have been checked - that all parts of the installation have worked correctly for a minimum of 240 hours straight with no interruptions or shutdowns caused by failures or breakdowns in the system, while also having met the following requirements:

- Delivery of all documentation required in these Specifications.
- Removal of excess material from the work site.
- Clean the occupied areas, with transportation of all waste to landfill.

During this period, the supplier shall be solely responsible for the operation of the systems supplied, and will train the operating personnel.

All items supplied, as well as the installation as a whole, are protected against defects in manufacture, installation or design in a one year guarantee, except for the photovoltaic modules and inverters, for which there will be a guarantee of 2 years counting from the date of signature of on the Provisional Acceptance Certificate. The modules will be guaranteed for 90% of nominal power to 10 years and 80% to 25 years.

The installer will, however, be obligated to repair the malfunctions that may occur when it is determined that these come from hidden defects in design, construction, assembly or materials, pledging to resolve these at no charge.

7 Technical requirements of maintenance contract

7.1 Generalities

A contract of preventive and corrective maintenance for at least three years will be established.

The maintenance contract of the installation includes all the elements of the installation, including the preventive maintenance as recommended by the different manufacturers.

7.2 Maintenance Program

The purpose of this section is to define the general minimum conditions that must be followed for the proper maintenance of solar energy photovoltaic installations connected to the grid.

Two action steps are defined that include all the necessary operations during the lifetime of the installation to ensure its operation, increase its production and prolong its functioning state:

- Preventive maintenance
- Corrective maintenance

The plan for preventive maintenance: these include visual inspections, verifications, and other actions, which when applied to the installation should enable it to keep within the limits of acceptable operating conditions, performance, protection and durability.

The plan for corrective maintenance: All replacement operations needed to ensure the system works properly during its lifetime. It includes:

- A visit to the installation whenever the user requires due to serious damage to it.
- The analysis and elaboration of the budgets for repair work and necessary replacements for the proper operation of the installation.
- The economic costs of corrective maintenance, to the extent indicated, are part of the price of the annual maintenance contract. Manpower or the replacement of the equipment necessary beyond the period of guarantee may not be included.

Maintenance must be performed by qualified service personnel under the responsibility of the installation company.

Preventive maintenance of the installation will include at least one annual visit in which the following activities will be undertaken:

- Checking of electrical protection.
- Checking the status of the module: checking the situation with respect to the original project and verifying the state of connections.
- Checking the status of the inverter: its operation, signal lights, alarms, etc.
- Checking the mechanical state of cables and terminals (including grounding cables and readjustments to terminals), plates, transformers, fans / pumps, unions, adjustments, cleaning.
- A clear trouble shooting way and contact information that EAEE Technical team can use in case of emergencies.
- A detailed maintenance plan including a maintenance checklist and technical support.
- A detailed cleaning mechanism for the PV system.
- The contractor must show his Commitment and not limited to provide the following:

- Response time for problem solving.
- Response time for solving software or configuration support.
- Response time for (hardware/software) failure of the system or Any other components related.
- Actions that will be taken during failure.
- Response time for failed equipment or any other components Replacements

A technical report for each of the visits will be prepared, which will indicate the state of the installations and describe any incidences.

The record of maintenance operations carried out will be kept in a maintenance log, which indicates the identification of the maintenance personnel (name, qualification and authorization of the company).

7.3 Guarantees

7.3.1 General scope

Notwithstanding any possible claims by third parties, the installation will be repaired in accordance with these terms and conditions in the case of a breakdown or due to faulty assembly or defect in any of the components, provided it has been properly handled in accordance with the provisions of the instruction manual.

The guarantee is granted on behalf of the buyer of the installation, which must be duly justified in the certificate of guarantee showing the date on which the certification of guarantee of the installation is accredited.

7.3.2 Terms

The supplier shall guarantee the installation for a minimum period of one year for all materials used and the procedure undertaken in its assembly. For the photovoltaic modules and inverters, the minimum guarantee is 5 years.

If there is an interruption to the execution of supply due to causes that are the responsibility of the supplier, or if there are repairs that the supplier must perform to comply with the stipulations of the guarantee, the period will be extended for the total duration of these interruptions.

7.3.3 Economic Conditions

The guarantee covers repairs to and replacements of, if necessary, components and parts that may be defective, as well as the labor used in the repair or replacement during the valid period of the guarantee.

All other expenses, such as travel time, transportation, depreciation of vehicles and equipment, required means and the collection and return of equipment to the manufacturer's workshop are expressly included.

In addition, the guarantee must include the labor and materials needed to make any timely adjustments for the operation of the installation.

If in a reasonable time period, the supplier is unable to fulfill the obligations contained in the guarantee, the buyer of the installation may, upon previously written notification, set a final date for said supplier to fulfill these obligations. If the supplier does not fulfill its obligations in this time period, the buyer may, on the account and risk of the supplier, carry out the necessary reparations, or hire a third party for carrying out these repairs, without prejudice of a possible complaint for damages incurred by the supplier.

7.3.4 Annulment of guarantee

The guarantee may be cancelled when the installation has been repaired, modified or disassembled, even if only in part, by people not expressly authorized by the supplier – when these are foreign to the supplier or outside the manufacturer's technical assistance service.

7.3.5 Place and Time of Service

When the user detects a defect in the operation of the installation, he or she will duly notify the supplier. When the supplier considers that it is a manufacturing defect of some component, he or she will duly contact the manufacturer.

The supplier will deal with any incident within a maximum period of one week and the resolution of t he damage done in a maximum of 15 days, except for a duly justified *force majeure.*

The failure of the installations will be repaired by the supplier on site. If the component can not be repaired on site, the component will be sent to the official workshop designated by the manufacturer at the supplier's charge.

The supplier will carry out repairs or replacements of parts as soon as possible after receiving notice of failure, but will not be responsible for damages caused by the delay in these repairs when handled in less than 15 calendar days.

Project funded by the EUROPEAN UNION

ENPI CBCMED
CROSS-BORDER COOPERATION IN THE MEDITERRANEAN

DIDSOLIT-PB

ANNEX 3

TENDER, TECHNICAL SPECIFICATIONS

BIPV System

WWW.DIDSOLIT. EU

SUMMARY

1 Object of contract 3

2 Description of Works to be Carried Out 5

2.1 Lot 1 (Supply of equipment): Supply of photovoltaic modules 5

3 Technical specifications and requirements of the components 5

3.1 Description of the principal parts of the project 5
3.2 Technical Requirements 5
3.2.1 Photovoltaic modules (Lot 1) 5
3.2.2 Characteristics of materials to tender 6

4 Obligations to fulfill in executing the contracts 7

4.1 General criteria 7
4.2 Lot 1 (Supply of Equipments) 8
4.2.1 General Obligations 8
4.2.2 Acquisition of material 8
4.2.3 Delivery of material 8

5 Calendar of execution of the contracts 11

5.1 Deadlines for execution of the contracts 11
5.1.1 Clauses and Clarifications 111

1. OBJECT OF CONTRACT

Contracting manufacturers and / or suppliers of equipment and photovoltaic companies specializing in the installation of integrated photovoltaic systems into buildings.

The contracting will be done through the Egyptian Association for Energy and Environment (EAEE) , as part of the European project DIDSOLIT-PB (CBCMED Programme ENPI).

The DIDSOLIT-PB's main objective is the promotion of decentralized solar technologies for electricity generation in public buildings.

The involvement of government agencies, both regulators as potential developers and users of these technologies, as well as technology transfer between Mediterranean regions and the promotion of SMEs in the sector are other elements of particular importance.

The previous research conducted in the project has led to the Technical Team's selection of four public buildings for carrying out the PV installation, as described in the attached Executive Project.

The uncertainty of the regulatory framework in the photovoltaic field, especially regards consumption, lead us to a zero injection to the Grid solution, despite it being designed to be able to interact with the Grid in the future if the regulatory framework becomes favourable.

The **object of the contract** to be performed, as defined in this Technical Specification, is the following:

LOT 1) The supply of PV modules for architectonic integration (different technologies), which are necessary to execute the four photovoltaic installations detailed herein.

LOT 2) The execution, installation, commissioning and legalization of four projects with integrated photovoltaic systems for self consumption and injection to the Grid.

Regards the integrated photovoltaic technologies (BIPV), the Technical Team of the DIDSOLIT-PB project has already developed a "benchmark" of the main components (PV modules and inverters), which has helped them to develop the technical and global economic proposal, as well as the binding Executive Projects schedule and Technical Specifications.

These studies will be made available to the company or companies that are awarded the tender contract(s).

Public buildings have been previously selected and the corresponding Executive Projects have been defined, which determine with precision the systems to be executed.

These Executive Projects, along with the Technical Specifications of the Health and Safety Study, comprise the core of the binding contract.

The Call for Tender is structured in 2 lots for Contracting.

Lot 1 (Supply of equipment): Supply of photovoltaic modules

The bidder's offer has to comply with the Tender Technical Specifications and the ones included at: Executive Project (EP) (PV module datasheet) and Project Technical Specifications (PTS) (general requirements).

The bidder has to prove previous experience in PV applications supply. It is necessary to prove a minimum supplied (installed and properly performing) power of about 100 kWp of similar photovoltaic technology.

Lot 2 (Services and Execution): Supply of Small Equipment, Implementation, Commissioning, start up and Legalization.

The bidder has to prove previous experience in PV applications installation. It's necessary to prove a minimum installed power of about 50 kWp of photovoltaic systems, including rooftop and BIPV applications.

The service and execution contract includes all small supplies, work execution, and the necessary monitoring and authentication to deliver the photovoltaic installation in a fully operational mode.

The bidder's offer has to comply with the present TenderTechnical Specifications and the ones included at: Executive Project (EP) (PV module datasheet), Project Technical Specifications (PTS) (general requirements) and Health & Safety (HS).

2. DESCRIPTION OF WORKS TO BE CARRIED OUT

2.1 Lot 1 (Supply of equipment): Supply of photovoltaic modules

The aim of this Lot is to supply modules for each of the four photovoltaic installations. Respecting the specifications included in the respective construction projects.

3. TECHNICAL SPECIFICATIONS AND REQUIREMENTS OF THE COMPONENTS

3.1 Description of the principal parts of the project

The principal and common parts of the installations require close-up treatment and strict control over the execution of the following:

Photovoltaic Modules uptake (Lot 1)
Inverters (Lot 2)
Monitoring System (Lot 2)
Software Self-consumption regime with injection to the Grid (Lot 2)
Primary and secondary structures (Lot 2)
Low voltage boxes (Lot 2)
Small electrical components (Lot 2)
Air-Conditioning units (Lot2)

3.2 Technical Requirements

(see Point 5. "Components and Materials" Project Technical Specifications annex)

3.2.1 Photovoltaic modules (Lot 1)

General aspects

Technologies selected:

Among the possible technologies available today in the market, project DIDSOLIT-PB has focused its research and development of architectural integration projects on the following technologies:

Crystalline Silicon Lens. Module laminated glass, semi-transparent (approx. 15-40% transparency)
Amorphous Silicon. Module laminated glass, semi-transparent (approx. 10-20% transparency)
Amorphous Silicon. Flexible module, without transparency, laminated with ETFE

The Executive Project includes the number of units and type of module for each project.

The manufacturer or supplier shall provide a technical file on the module in question, detailing the technical specifications and binding it to the certificate of manufacture and product.
Generic certificates will not be accepted on similar modules unless they belong to a recognized certificate for a family of products.
The bidder must provide information and recommendations that allow validation of the composition and mechanical compatibility of the laminated glass modules, the effects of static and dynamic loads, and of the fixing systems foreseen.
All modules are frameless and it is expected that they are integrated in the construction elements of the building or in adjoining structures, by way of auxiliary fasteners, while respecting the integrity of the building.

3.2.2 Characteristics of materials to tender

Semitransparent glass-laminated PV modules

GENERAL REQUIREMENTS:

Mechanical and constructive parameters:
The type of cells will be crystalline, 156 x 156 mm (both monocrystalline and crystalline are accepted, provided they fulfil the requested electrical parameters).
The PV module will be glass laminated.
The glass thickness indicated is a minimum value that has to be respected. However, providers, contractors have to take the responsibility on the appropriate glass thickness for each application-project (personal safety, static and dynamic loads, etc).
For crystalline modules: from 4 mm + laminations foils +cells + 4 mm, up to 6 mm, when the integration conditions requires.
PVB will be accepted as lamination layer. In case EVA is proposed, the manufacturer has to detail its mechanical properties and demonstrate its suitability for building integration requirements.
The glass dimensions requested at the Project technical datasheet have to be respected, unless a deviation margin is explicitly accepted.
Manufacturers standard dimensions might be not suitable in some projects.
Manufacturers and providers must certify each of the customized solutions.
Depending on lighting, shadow requirements, technology and glass dimensions, the PV module transparency might vary from 10 to 40%. In any case, a minimum 10% of transparency is required.
Unless another transparency is requested
Semitransparent thin film: 10-20%
Semitransparent crystalline: 10-40%
All the providers must include polished edges in their final offers in order to minimize the risk of glass cracking.
PV modules will include:
Edge or back terminal junction box (according to each technical datasheet included in the Project).
2.5 or 4 mm2 wiring section
Connectors MC3 or MC4
Bypass diodes for shadow tolerance
Protection IP65
All modules will be frameless. They are going to be integrated into the building substructure using specific fixations.

The specific parameters will be included into the Executive Project PV module datasheet.

Electrical parameters:
The specific parameters to be fulfilled are detailed into the Executive Project PV module datasheet: Nominal power, rated voltage, rated current, open circuit voltage, short circuit current, max. system voltage, electrical protection class (Class II).

See the "PV module datasheet" include in Executive Project (EP)

Flexible thin film modules:

General requirements:

Mechanical and constructive parameters:
The type of cells will a-Si (amorphous silicon).
The PV module will be flexible and laminated with EFTE.
The encapsulant has to be EFTE, high light-transmissive polymer.
The total thickness will be 4 mm.
The module dimensions requested at the Project technical datasheet have to be respected, unless a deviation margin is explicitly accepted.
The module doesn't have any transparency.
All the providers must suggest and detail the suitable fixation systems: adhesive (3M or similar) and/or mechanical.
PV modules will include:
-back terminal junction box (according to each technical datasheet included in the Project).
-2.5 or 4 mm2 wiring section
-Connectors MC3 or MC4
-Bypass diodes for shadow tolerance
-Protection IP65
The specific parameters will be included into the Executive Project PV module datasheet

Electrical parameters:
The specific parameters to be fulfilled are detailed into the Executive Project PV module datasheet: Nominal power, rated voltage, rated current, open circuit voltage, short circuit current, max. system voltage, electrical protection class (Class II).

See the "PV module datasheet" include in Executive Project (EP)

4. OBLIGATIONS TO FULFILL IN EXECUTING THE CONTRACTS

4.1 General criteria

Bidders for Lot 1 and Lot 2 have to comply with the technical requirements included in the Tender documents:

Executive Project for the Tender: Description report, Work Plan, Measurements, Drawings and schemes
Project Technical Specifications
Health and Security Study

4.2 Lot 1 (Supply of Equipments)

4.2.1 General Obligations

The bidder of each contracting block will have sufficient staff in number and qualifications to develop the appropriate service, guaranteeing the performance .
The bidder must be a manufacturer, and participate in the process of developing the module or be the direct distributor of it. It must offer maximum guarantees of manufacturing and post-sales service.
The bidder must provide information and recommendations that allow for validating the composition and mechanical compatibility of the laminated glass modules, the effects of static and dynamic loads, and of the fixing systems foreseen.
The bidder must ensure that the packaging allows the safe transport and integrity of equipment, depending on the requirements of the project.
The bidder will be responsible of the material integrity from the fabrication center to the building site . An insurance will be required.
The bidder has to coordinate, control and certificate the material in coordination with the installer company (Lot 2).
The definitive dimensions of the PV modules will require the validation of the company contracted to execute the installation (Lot 2).
All the transportation costs and taxes are included in the bidder offer. Unless it is explicitly agreed with the contractor.

4.2.2 Acquisition of material

The bidder will present the details of the Technical Specifications and the manufacturer selected prior to the awarding process of the contract (Administrative Clauses) For scoring.
The bidder has to fulfill the present Technical Specifications and the ones included at: Executive Project (EP) (PV module datasheet), Project Technical Specifications (PTS) (general requirements) .

4.2.3 Delivery of material

The material will be delivered to the 4 Buildings sites, fulfilling the agreed maximum term agreed in the contract with the company responsible for the installation of the system (Lot 2), in case of this company not be the same one awarded both contracts.
In any case, the delivery time must not exceed three months after signing the contract with the installer company (Lot 2).

Administrative Norms

General responsibilities and obligations of THE CONTRACTED ENTITY

The winning bidder is obligated to fulfil the Technical Specifications and Administrative Clauses as presented in this Call for Tender.

Documentation

The winning bidder will provide the Contractor the following documents and certificates:

Maintenance User Manual of the product.
PV module technical datasheet and certifications, including the certification of origin.

Rule of Origin:

The tenderer must state the origin of supplies. The term "origin" is defined in articles 23 and 24 of Council Regulation (EEC) No 2913/92 of 12 October 1992 establishing the Community Customs Code and other Community legislation governing non-preferential origin.

The certificate of origin must be made out by the competent authorities of the country of origin of the supplies and must comply with the rules laid down by the relevant Community legislation.

EU Member States:

Portugal, Spain, France, Italy, Malta, Greece, Cyprus, Bulgaria, Romania, Poland, Czech Republic, Slovakia, Hungary, Slovenia, Austria, Germany, Lithuania, Latvia, Estonia, Finland, Sweden, Denmark, The Netherlands, Belgium, Luxemburg, United Kingdom and Ireland

ENPI Partner Countries

Russia, Belarus, Ukraine, Moldova, Georgia, Armenia, Azerbaijan, Algeria, Egypt, Israel, Jordan, Lebanon, Morocco, Occupied Palestinian Territories, Syria and Tunisia,

IPA Countries

Croatia, Turkey, Albania, Bosnia, Montenegro, Serbia, Kosovo and FYROM

EEA

Norway, Iceland and Liechtenstein

WHAT IS MEANT BY THE TERM ORIGIN

For the purpose of Annex IV, the term 'origin' is defined by Council Regulation34 as the economic nationality of goods in international trade:

Goods originating in a country shall be those wholly obtained or produced in that country (Article 23)

Goods whose production involved more than one country shall be deemed to originate in the country where they underwent their last, substantial, economically justified processing or working in an undertaking equipped for that purpose and resulting in the manufacture of a new product or representing an important stage of manufacture (Article 24)

Supplies and materials affected by the rule of origin:

Include the materials to be used in construction

Do not include the Contractor's own equipment (machines, tools, etc.) to be used during construction.

COUNCIL REGULATION (EEC) No 2913/92 of 12 October 1992 establishing the Community Customs Code and other Community legislation governing non-preferential origin.

Fabrication certificates:

Tested according to: EN 14449, EN 12150, EN 12600, EN 12543,1-6
Designed and produced according to: EN 61215 (Crystalline), UNE-EN 61646 (thin film), EN 61730 safety class II
Compulsory certificates: Certificate of Origin
Additional certificates: TÜV certificate, CE certificate

Inspection and Reception of the Works

The supplier and installer must provide the Final Acceptance Test (FAT) report.

The contractor is responsible to restore the site in the same original conditions.

Guarantees

The supplier and installer install will guarantee for a minimum period of two years of all the materials used and of the procedure used in assembly (preventive/corrective guarantee period).

(see point 6. "Reception and Tests" and 7. "Technical Requirements of the maintenance contract" for the Project Technical Specifications attached)

Crystalline and Thin Film semitransparent PV modules

2 years product guarantee

years on power output at 90%

20 years on power output at 80%

Thin film semitransparent PV modules

2 years product guarantee

20 years on power output at 80%

Flexible Thin film PV modules

2 years product guarantee

20 years on power output at 80%

5. CALENDAR OF EXECUTION OF THE CONTRACTS

5.1 Deadlines for execution of the contracts

Lot 1 (Supply of equipments):

The deadline for completion of supply of equipment will be 14 weeks after formally signing the contract**.**
The material will be delivered to the destination defined by the contractor, fulfilling the agreed maximum term agreed in the contract with the company responsible for the installation of the system (Lot 2), should this company not be the same one awarded both contracts.
In any case, the delivery time must not exceed 12 weeks after the validation of the dimensions by the installer company (Lot 2).
The contractor of Lot 2 has two weeks to validate the dimensions, after the signature of the contract.

5.1.1 Clauses and Clarifications

The delay in the delivery validation of the dimensions by the contractor of Lot 2, may be accepted as grounds for extension of the contract.

General statement on the European Union

The European Union is made up of 27 Member States who have decided to gradually link together their know-how, resources and destinies. Together, during a period of enlargement of 50 years, they have built a zone of stability, democracy and sustainable development whilst maintaining cultural diversity, tolerance and individual freedoms. The European Union is committed to sharing its achievements and its values with countries and peoples beyond its borders.

بيان عام عن الاتحاد الأوروبي

يتكوّن الإتحاد الاوروبي من ال ٢٧ الدول الأعضاء الذين قرروا معاً ربط خبراتهم والموارد ومصائرها. معاً، وخلال فترة ٥٠ عاماً من التوسع، تم بناء منطقة من الإستقرار، الديمقراطية والتنمية المستدامة مع الحفاظ على التنوع الثقافي، التسامح والحريات الفردية. يلتزم الإتحاد الأوروبي في تقاسم إنجازاته وقيمه مع الدول والشعوب خارج حدوده.

General statement on the European Union (Greek)

Η Ευρωπαϊκή Ένωση αποτελείται από 27 ΚράτηΜέλη πουέχουν αποφασίσει να συνδέσουνσταδιακά τηντεχνογνωσία, τους πόρους και τομέλλοντους. Κατάτηδιάρκεια μιας περιόδουδιεύρυνσης 50 ετών, έχουνδημιουργήσει μαζίμια ζώνησταθερότητας, δημοκρατίας και αειφόρου ανάπτυξης διατηρώντας παράλληλα την πολιτιστική πολυμορφία, τηδιαφορετικότητα και τις ατομικέςτουςελευθερίες. Η Ευρωπαϊκή Ένωσηέχειδεσμευθεί να μοιράζεται τα επιτεύγματα και τις αξίεςτηςμεχώρες και λαούς που βρίσκονται εκτόςτωνσυνόρωντης.

Statement about the Programmers

The 2007-2013 ENPI CBC Mediterranean Sea Basin Programme is a multilateral Cross-Border Cooperation initiative funded by the European Neighbourhood and Partnership Instrument (ENPI). The Programme objective is to promote the sustainable and harmonious cooperation process at the Mediterranean Basin level by dealing with the common challenges and enhancing its endogenous potential. It finances cooperation projects as a contribution to the economic, social, environmental and cultural development of the Mediterranean region. The following 14 countries participate in the Programme: Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Malta, Palestinian Authority, Portugal, Spain, Syria, Tunisia. The Joint Managing Authority (JMA) is the Autonomous Region of Sardinia (Italy). Official Programme languages are Arabic, English and French.

بيان حول البرنامج

إن برنامج NPI CBC MedE 2007 – 2013 هو برنامج للتعاون المشترك عبر الحدود لحوض البحر الأبيض المتوسط، هو جزء من سياسة الجوار والشراكة الأوروبية ومن آلياتها التمويلية. يهدف هذا البرنامج إلى تعزيز ودعم عملية التعاون المستدام والمنسجم على مستوى حوض البحر الأبيض المتوسط وذلك من خلال معالجة التحديات المشتركة وتعزيز الإمكانات الذاتية. يموّل البرنامج مشاريع التعاون كمساهمة في التنمية الإقتصادية، الإجتماعية، البيئية والثقافية لمنطقة البحر الأبيض المتوسط. إن الدول ال ١٤ التالية هي الدول المشاركة في البرنامج: قبرص، مصر، فرنسا، اليونان، إسرائيل، إيطاليا، الأردن، لبنان، مالطا، السلطة الفلسطينية، البرتغال، إسبانيا، سوريّا، تونس. إن سلطة الإدارة المشتركة JMA هي منطقة الحكم الذاتي لمقاطعة سردينيا (إيطاليا). إن اللغات الرسمية للبرنامج هي : العربية ، الإنجليزية والفرنسية.

Statement about the Programme

ΤοΠρόγραμμα Διασυνοριακής Συνεργασίας Μεσογειακής Λεκάνης (ENPI CBC Mediterranean Sea Basin) 2007-2013 είναι μια πολυμερής πρωτοβουλία Διασυνοριακής Συνεργασίας η οποία χρηματοδοτείται από τοΕυρωπαϊκό ΜέσοΓειτονίας και Εταιρικής Σχέσης (ENPI).ΤοΠρόγραμμα έχει σαν στόχο να συμβάλει στην προώθησητης βιώσιμης και αρμονικήςσυνεργασίας στην περιοχήτηςΜεσογειακής Λεκάνης αξιοποιώντας πλήρωςτιςενδογενείςδυνατότητες της περιοχής και αντιμετωπίζοντας τιςκοινές προκλήσεις.Χρηματοδοτεί έργα συνεργασίας τα οποία συμβάλλουν στηνοικονομική, κοινωνική, περιβαλλοντική και πολιτιστική ανάπτυξης τηςΜεσογείου. ΣτοΠρόγραμμα συμμετέχουνοι ακόλουθες 14 χώρες: Κύπρος, Αίγυπτος, Γαλλία, Ελλάδα, Ισραήλ, Ιταλία, Ιορδανία, Λίβανος, Μάλτα, Παλαισπνιακή Αρχή, Πορτογαλία, Ισπανία, Συρία, Τυνησία. Η ΚοινήΔιαχειριστική Αρχή (ΚΔΑ) τουΠρογράμματος, είναι η ΑυτόνομηΠεριφέρεια της Σαρδηνίας (Ιταλία). Επίσημεςγλώσσεςτουπρογράμματος είναι τα Αραβικά, Αγγλικά και Γαλλικά.

*The project DIDSOLIT-PB is implemented under the ENPI CBC Mediterranean Sea Basin Programme (*www.enpicbcmed.eu*). Its total budget is 4,3 million Euro, and it is financed, for an amount of 4,1 million Euro, by the European Union through the EuropeanNeighbourhood and Partnership Instrument. The ENPI CBC Med Programme aims at reinforcing cooperation between the European Union and partner countries regions placed along theshores of the Mediterranean Sea."*

Disclaimer
This publication has been produced with the financial assistance of the European Union under the ENPI CBC Mediterranean Sea Basin Programme. The contents of this document are the sole responsibility of <BEG-DIDSOLIT-PB> and can under no circumstances be regarded as reflecting the position of the European Union or of the Programme's management structures.

تنبيه
لقد تم إعداد هذه النشرة بمساعدة مالية من الإتحاد الأوروبي في إطار برنامج التعاون المشترك عبر الحدود لحوض البحر الأبيض المتوسط "ENPI CBC Med". إن محتويات هذه الوثيقة من مسؤولية ---------- ولا تعكس تحت أي ظرف من الظروف رأي الإتحاد الأوروبي أو الهياكل الداخلية للبرنامج.

Disclaimer
Το παρόν έγγραφο έχει εκδοθεί με τη χρηματική συνεισφορά της Ευρωπαϊκής Ένωσης στο πλαίσιο του Προγράμματος Διασυνοριακής Συνεργασίας Μεσογειακής Λεκάνης ENPI Med. Το περιεχόμενο αυτού του εγγράφου είναι αποκλειστικά ευθύνη του <BEG-DIDSOLIT-PB> και δεν μπορεί σε καμιά περίπτωση να θεωρηθεί ότι αντικατοπτρίζει τη θέση της Ευρωπαϊκής Ένωσης ή των δομών διαχείρισης του Προγράμματος.

European Union web links

http://ec.europa.eu/world/.

EuropeAid Development and Cooperation Office http://ec.europa.eu/europeaid/index_en.htm

ENPI CBC Med Programmehttp://www.enpicbcmed.eu

This publication has been produced with the assistance of the European Union. The contents of this publication are the sole responsibility of the author of this document and can in no way be taken to reflect the views of the European Union."

Disclaimer – This document has been prepared solely for information purposes for the use of the recipient and without any commitment or responsibility on our part. DIDSOLIT-PB(Including all project partners) accepts no liability for any direct orconsequential loss arising from the transmission of this information to third parties. This report is current at the date ofwriting only and we will not be responsible for informing you of any future changes in circumstances which may affectthe accuracy of the information contained in this report.

This document and the information contained herein is provided on an "As Is" basis and the DIDSOLIT-PB disclaims all warranties, express or implied, including but not limited to any warranty that the use of the information herein will not infringe any rights or any implied warranties of merchantability or fitness for a particular purpose."

DIDSOLIT-PB is a project financed by European Union programs known as ENPI CBCMED and regulated by Spanish laws.
DIDSOLIT –PB is based in Edifici Eureka. UniversitatAutònoma de Barcelona Campus. 08193 Bellaterra(Cerdanyola del Vallés) Barcelona. Spain

Project funded by the EUROPEAN UNION

ENPI CBCMED
CROSS-BORDER COOPERATION IN THE MEDITERRANEAN

DIDS LIT-PB

ANNEX 4

Health & Safety Study BIPV System

SUMMARY

1 Health & Safety Study 5
1.1 Object of the study 5
1.2 Preliminary considerations 5
1.2.1 Introduction 5
1.2.2 Health and safety 5
1.3 Report guide-lines 6
1.3.1 General information 6
1.3.2 Description and summary of hazard 6
1.3.3 Specific health & safety instructions 6
1.3.4 Legal specifications 10

1 HEALTH & SAFETY STUDY

1.1 Object of the study

The present Health and Safety Study aims to define the necessary technical systems for the building construction in the most adequate Health and Safety conditions in the workplace, following the described recommendations and articles. It will also be in permanent disposition for the Social Security and Work Inspection and for the Technicians of the Health and Safety Technical Provincial Departments to enable them to carry on their duties.

The aim of the Health and Safety Study is to:

- Preserve the integrity of the workers and surrounding people
- Set up a work organization that minimizes risks
- Determine the required facilities and equipment for the Collective and Individual Protection of all the workers involved
- Define the Hygiene and the Well-being facilities for the workers
- Establish the use regulations of the Safety Elements
- Provide the workers with the necessary knowledge for the correct and safe use of the equipment and machinery that they are entrusted with
- Provide for First Aid and evacuation of the injured
- Establish actions of the Health and Safety Committees.

1.2 Preliminary considerations

1.2.1 Introduction

Prior to commencement of installation or working with solar PV system components ensure that:

- All personnel involved with the installation / usage of solar PV System / product has to read carefully the manuals of the equipment in these designs and be thoroughly familiar with the health and safety aspects of solar PV systems products.
- Preserve these manuals and store them at an easily accessible place.
- All products conform to the specifications. The installer and the owner are requested to use the product in accordance with the user Manual and under normal conditions.

1.2.2 Health and safety

Solar Electric systems contain hazardous materials and voltages. For the protection of yourself and others please read these instructions carefully.

• Make sure that everybody working with your system reads and understands the safety requirements.
• Remove all metallic ornaments like wristwatch, jewelery, etc., use insulated tools, wear PPE's for relevant Installations.
• Follow the connection and disconnection Sequence of Cables, interconnecting the Charge controller, solar array, Battery Bank, Load, voltage Regulator etc.
• Don't short the output terminals of the solar PV components.

1.3 Report guide-lines

In the necessary cases it contains and justifies the Safety measures to prevent the variety of risks that may arise during the building's construction.

1.3.1 General information

• Building data - Location - Surroundings
• Contractor company
• Author of the Study, Site Manager and Safety Manager
• Nearest health centre - injured evacuation
• Budget, execution planning and maximum number of workers
• Description of the building: layout
• Work procedure
• Building construction planning
• Auxiliary installations
• Available auxiliary measures at the building site.

1.3.2 Description and summary of hazard

Caution symbols that are normally used and their respective explanations.

1.3.3 Specific health &safety instructions

1.3.3.1 Solar modules

A photovoltaic module exposed to daylight produces electricity. It is always necessary to consider the PV elements (modules, module series, branches) under power, even if the DC and AC switches are open.

The Solar Modules generate DC electricity whenever sunlight shines on the solar cells.

• Solar modules should be mounted firmly on to the structure
• Potentially lethal voltages can be developed from arrays. Therefore, the Modules should be shaded from sun by opaque sheeting, before any electrical connections are made to the modules

While working on the facade, disconnect the modules from the building's electrical installation with the main power switch.

Never disconnect or connect the modules without first opening the circuit.

Switch off or disconnect the load before modifying the branch connections on the modules under power. Photovoltaic systems are considered to be low voltage systems.

However, the system's maximum voltage is generally very high. The in-series connection of the modules will add each module's voltages; the total voltage will exceed the safety threshold of 120 VDC related to the low voltage, but should not be greater than the input voltage of the inverters. For SUNEAL photovoltaic blade, this maximum voltage is fixed at 600 VDC (even though the component's certified protection class II allows a maximum voltage of 1000 VDC).

1.3.3.2 Control electronics

Control electronics is necessary to monitor and for proper sequencing of various system operations so that the solar energy is utilized efficiently. Read the instructions described in the relevant product manual thoroughly before installing or working with the product.

Use only insulated tools and meters during installation and periodic maintenance. Otherwise, it may give you an electric shock.

Do not interfere with any electronic components while it is in working condition. It may contain dangerous voltages.

Ensure all electronic equipment is properly grounded (as applicable).

Do not attempt to service the unit at component level.

While trouble shooting, make sure the PCB assemblies are removed only after disconnecting solar array and battery. Follow the connection and disconnection sequence as recommended.

1.3.3.3 Grounding & lightning

Lightning is one of the most awesome phenomena of nature and produces both electric and magnetic fields which vary with distance, frequency and time. Due to the advantages of low maintenance and autonomous operation, solar power arrays are situated in many diverse, isolated and extreme locations throughout the world. Protection against a direct lightning strike should only be necessary for critical applications or where the probability of a lightning strike is high. In general effective grounding of solar array structures and associated equipment will give adequate protection in the field.

Use the lightning protection components as recommended and install at appropriate places

as mentioned in the installation / user manual.

Grounding the solar PV system is important for both safety and protection against lightning. Grounding the equipment ensures that the system voltage cannot drift away from ground potential and thus reduces the risk of electric shocks. Adequate grounding also provides a path for fault currents induced by lightning.

To make the solar power system as safe and secure as possible, all exposed metal (e.g. solar array structure, charge Controller / panel enclosure, metal cable conduits etc.) should be grounded. Use super grounding kits for grounding purposes if it is recommended in the product / system.

Electrical grounding leakage on stationary battery installations can lead to low temperature carbonization fires. This can happen with valve regulated batteries. Ground leakage can also arise due to physically leaking cells or block batteries because of damaged housings or due to leakage through the valve , especially in case of horizontal installations.

Ground leakage is possible, for instance with earthed racks or battery compartments or where these are in direct ground contact. Over time, acid concentration through evaporation of water can happen, leading to reduced level of insulation resistance. It follows that the use of insulated racks or compartments is not a complete solution in the long term. Therefore, during inspection of the battery, the following systems are looked for:

- Traces of acid on the battery housing, racks, connectors
- Traces of corrosion on racks or compartments
- Crystalline, white sediments on the battery housings, racks, compartments,
- Connectors

During inspections, measurement of earth leakage should be carried out. The results from the measurements, compared with previous results, will enable changes to be detected.

1.3.3.4 Structural assembly

Construction of structure must not be attempted in high winds

- Care must be taken in lifting structural members and while working at above ground level
- Protective headgear should be worn at all times
- Refer to relevant drawings for structures and foundation details. Follow the installation sequence.

1.3.3.5 Emergency guide-lines

ACID ON SKIN	Wash skin immediately with water. Remove contaminated clothing . Wash again and again .
ACID in EYES	Wash eyes out with clean water for some time. Ask for IMMEDIATE medical attention.

ACID SPILLAGE Sprinkle sodium bicarbonate (baking powder) on to the affected area, and wash down with plenty of water

ELECTRIC SHOCK Switch OFF the circuit breakers and give first aid to the patient and seek immediate medical attention. Never switch ON the unit unless it is thoroughly checked and diagnosed for reasons of electric shocks.

1.3.4 Legal specifications

1.3.4.1 Responsibilities

The contractor will be responsible of the correct execution of the safety measures of the subcontracted parties. He will respond supportively to the consequences that may arise of the attributable subcontractor's lack of vigilance.

1.3.4.2 Obligations

The contract company has the obligation to comply with the directives of the Health and Safety Study.

The personal protective measures have to be approved by a competent organisation. If they are not available in the present market, the most adequate ones shall be used. These shall be defined by the technical criteria of the safety services of the contracted company with the contractor company.

Taking into consideration any normalized model that could be used by the contractor, the accident and defects reports have to include the following minimum information:

A) Accident report.

- Identification of the construction work.
- Day, month and year of the day the accident happened.
- Time of the accident.
- Name of the injured.
- Professional standing and trade of the injured.
- Address of the injured.
- Place where the accident occurred.
- Cause of the accident.
- Apparent importance of the accident.
- Possible specifications of human errors.

- Place, person and way in which the first aid took place (doctor, nurse, first aider, other construction work personnel).
- Place where the injured was taken for hospitalization.
- Witnesses of the accident (nominal verification and versions).

To complement this part, a report has to be made containing:

- How could it have been avoided??
- Immediate orders to do

B) Deficiencies report

- Identification of the construction work
- Date of the observations
- Place where the observation took place
- Report of the deficiency observed
- Study to solve the existing deficiency

1.3.4.3 Insurance.

It is perceptive during the building construction that the liable technicians have professional indemnity insurance. However, the contractor has to have the required professional indemnity insurance to cover its industrial activity. This insurance should cover the inherent risk of its activity towards third parties of which the contractor could be liable outside the contract, by its own fault or negligence, or the people he is liable for. It is understood that this professional indemnity insurance covers the workers professional indemnity insurance.

The contractor is obliged to have a full cover construction insurance policy during the construction of the building, with an extension during the maintenance period of one year after the finishing date of the building.

Project funded by the EUROPEAN UNION

ENPI CBCMED
CROSS-BORDER COOPERATION IN THE MEDITERRANEAN

DIDSOLIT-PB

ANNEX 5

PV module datasheet

To be fulfilled by the supplier

WWW.DIDSOLIT. EU

ANNEX 5. PV Modules Data Sheets

POLY CRYSTALINE MODULES

Glass Laminated Semitransparent Crystalline Modules	
Project name and location:	**Governorate's building, Matrouh**
Number of PV module units (approx.)	
System size (approx.)	**44.2kWp**
Technology	**Glass/Glass laminate**
Glass composition	
Encapsulant	
Total thickness	
Size	
Weight	
Transparency (%)	
Module efficiency	
Type of cells	
Number of cells	
Distance between PV cells	
Junction box	
Mounting (frame)	
Electrical parameters (STC) 1000 W/m^2	
Nominal power Pnom (approx)	
Power / m^2	
Rated Voltage [V_{MPP}]	
rated Current [I_{MPP}]	
Open circuit voltage [V_{oc}]	
Short circuit current [I_{SC}]	
Max. System voltage	
Electrical protection class	
Quality and Safety	
Tested according	EN 14449, EN 12150, EN 12600, EN 12543,1-6
Designed and produced according	EN 61215, EN 61730
Certificates	TÜV certificate Origen certificate
Warranty	2 year product guarantee 10 year on power output at 90% 20 years on power output at 80%
Conditions	
Packaging and transportation costs	
Delivery time	

Parameters to be defined by the Bidder (PV module manufacturer), according to general layout

POLY CRYSTALINE MODULES

Glass Laminated Semitransparent Crystalline Modules	
Project name and location:	**MEILS Language School, Matrouh**
Number of PV module units (approx.)	
System size (approx.)	**5kWp**
Technology	**Glass/Glass laminate**
Glass composition	
Encapsulant	
Total thickness	
Size	
Weight	
Transparency (%)	
Module efficiency	
Type of cells	
Number of cells	
Distance between PV cells	
Junction box	
Mounting (frame)	
Electrical parameters (STC) 1000 W/m^2	
Nominal power Pnom (approx)	
Power / m^2	
Rated Voltage [V_{MPP}]	
rated Current [I_{MPP}]	
Open circuit voltage [V_{oc}]	
Short circuit current [I_{SC}]	
Max. System voltage	
Electrical protection class	
Quality and Safety	
Tested according	EN 14449, EN 12150, EN 12600, EN 12543,1-6
Designed and produced according	EN 61215, EN 61730
Certificates	TÜV certificate Origen certificate
Warranty	2 year product guarantee 10 year on power output at 90% 20 years on power output at 80%
Conditions	
Packaging and transportation costs	
Delivery time	

Parameters to be defined by the Bidder (PV module manufacturer), according to general layout.

THIN FILM MODULES

Glass Laminated Semitransparent Thin Film Modules	
Project name and location:	**Matrouh General Hospital - Matrouh**
Number of PV module units (approx.)	
System size (approx.)	**20kWp**
Technology	**Glass/Glass laminate**
Glass composition	
Encapsulant	
Total thickness	
Size	
Weight	
Transparency (%)	
Module efficiency	
Type of cells	
Junction box	
Mounting (frame)	
Electrical parameters (STC) 1000 W/m^2	
Nominal power Pnom (approx)	
Power / m^2	
Rated Voltage [V_{MPP}]	
rated Current [I_{MPP}]	
Open circuit voltage [V_{oc}]	
Short circuit current [I_{SC}]	
Max. System voltage	
Electrical protection class	
Quality and Safety	
Tested according	EN 14449, EN 12150, EN 12600, EN 12543,1-6
Designed and produced according	EN 61215, EN 61730
Certificates	TÜV certificate Origen certificate
Warranty	2 year product guarantee 10 year on power output at 90% 20 years on power output at 80%
Conditions	
Packaging and transportation costs	
Delivery time	

Parameters to be defined by the Bidder (PV module manufacturer), according to general layout.

FLEXIBLE THIN FILM (EFTE) MODULES

EFTE Laminated Flexible Thin Film (a-Si) Modules	
Project name and location:	**Public Library - Matrouh**
Number of PV module units (approx.)	
System size (approx.)	
Technology	EFTE laminate flexible / Thin Film
Laminated composition	Polymer on the front side highly transparent and UV and weathering resistant EFTE
Encapsulant	
Total thickness	
Size	
Weight	
Transparency (%)	
Module efficiency	
Type of cells	
Number of cells	
Junction box	
Mounting (frame)	
Electrical parameters (STC) 1000 W/m^2	
Nominal power Pnom (approx)	
Power / m^2	
Rated Voltage [V_{MPP}]	
rated Current [I_{MPP}]	
Open circuit voltage [V_{oc}]	
Short circuit current [I_{SC}]	
Max. System voltage	
Electrical protection class	
Quality and Safety	
Tested according	EN 14449, EN 12150, EN 12600, EN 12543,1-6
Designed and produced according	EN 61215, EN 61730
Certificates	TÜV certificate Origen certificate
Warranty	2 year product guarantee 20 years on power output at 80%
Conditions	
Packaging and transportation costs	
Delivery time	

Parameters to be defined by the Bidder (PV module manufacturer), according to general layout.